

Pulp and Paper Industry Byproducts

551. **13C/12C composition, a novel parameter to study the downward migration of paper sludge in soils.**

Lichtfouse, Eric; Rogers, Karyne; Payet, Cecile; and Renat, Jean-Christophe

Geochemical Transactions 3(6): 2002. (2002); ISSN: 1467-4866.

Notes: References: 15; illus. DOI: 10.1039/b205560k.

Descriptors: C-13/ C-12/ carbon/ environmental effects/ industrial waste/ isotope ratios/ isotopes/ pollution/ sewage sludge/ sludge/ soils/ stable isotopes/ Environmental geology/ Geochemistry of rocks, soils, and sediments
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552. **13c study of soils 8 years after paper sludge disposal.**

Lichtfouse, Eric; Rogers, Karyne; Payet, Cecile; and Renat, Christophe.

In: 223rd National Meeting of the American Chemical Society, Orlando, FL, USA.; Vol. 223(1-2): GEOC 8.; 2002.

Notes: ISSN: 0065-7727.

Descriptors: biochemistry and molecular biophysics/ soil science/ terrestrial ecology: ecology, environmental sciences/ waste management: sanitation/ paper sludge disposal: agricultural lands, forestry lands, waste disposal method/ soil properties/ meeting abstract

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553. **Accumulation and availability of Zn, Cu, Mn and Fe in soils polluted with paper mill waste water.**

Matli Srinivaschari; Dhakshinamoorthy, M.; and Arunachalam, G.

Madras Agricultural Journal 87(4/6): 237-240. (2000)

NAL Call #: 22 M262; ISSN: 0024-9602

Descriptors: application date/ copper/ electrical conductivity/ gypsum/ iron/ irrigation/ irrigation water/ manganese/ NPK fertilizers/ nutrient availability/ paper mill sludge/ polluted soils/ rice/ rice husks/ soil amendments/ soil fertility/ soil ph/ soil pollution/ soil toxicity/ trace elements/ waste water/ zinc/ Madras/ microelements/ Mn/ paddy/ rice hulls/ toxic soils/ watering

Abstract: Field experiments were conducted at M/s Sun Paper Mill Farms, Cheranmahadevi, Tamil Nadu, India, during Kar (June-August) and Pishanam (November-February) seasons, 1995-96, to determine the effect of continuous use of paper mill waste water on the accumulation of Zn, Cu, Fe and Mn in soil. The treatments included three different irrigation sources and three soil amendments (NPK at 120:60:60 kg ha⁻¹, rice husk ash and gypsum) with rice cv. ASD36 as test crop. Soils irrigated with paper mill waste water increased soil pH and electrical conductivity (EC) in both seasons. Gypsum was better in lowering pH than rice husk ash; whereas for EC, rice husk ash proved better. DTPA extractable Zn, Cu, Fe and Mn largely accumulated in the upper 15 cm soil depth and the extent of their accumulation was increased with increased time of application. Application of rice husk ash proved significant in preventing micronutrients from reaching toxic levels in soil.

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554. **Active carbon pools and enzyme activities in soils amended with de-inking paper sludge.**

Chantigny, M. H.; Angers, D. A.; and Beauchamp, C. J.

Canadian Journal of Soil Science 80(1): 99-105. (2000)

NAL Call #: 56.8 C162; ISSN: 0008-4271

Descriptors: alkaline phosphatase/ application rates/ available water/ biomass/ carbendazim/ carbon/ deficiency/ enzyme activity/ hydrolysis/ incorporation/ interference/ levelling/ microbial flora/ microorganisms/ organic matter/ paper mill sludge/ phosphoric monoester hydrolases/ physical properties/ properties/ sludges/ soil/ soil amendments/ soil organic matter/ soil water/ soil water content/ wastes/ water availability/ water content/ alkaline phosphomonoesterase/ carbendazol/ MBC/ medamine/ micro organisms/ microbial biomass/ microflora/ organic matter in soil/ phosphatases/ soil moisture

Abstract: A field study was undertaken in Quebec province, Canada, on a well-drained clay loam and a poorly drained silty clay loam amended with de-inking paper sludge (DPS) at rates of 0 (control), 50 or 100 t ha⁻¹. K₂SO₄-extractable C (C_{ext}), soil water content (SWC), microbial biomass C (MBC) and different enzyme activity rates were periodically measured in soil during 1075 d following DPS incorporation. Compared with control soils, C_{ext} content increased by 100 to 200%, and soil water content increased by 35% following incorporation of DPS at 100 t ha⁻¹. Those differences decreased in time as DPS decomposed. Soil MBC increased proportionally with the rate of DPS amendment and was approx. twice the amount in soils amended with 100 t ha⁻¹ compared with the control. Microbial quotient (ratio of MBC to total soil organic C) was greater in DPS-amended than in control soils until day 370, reflecting the input of labile C from DPS. Compared with the control, fluorescein diacetate hydrolysis and alkaline phosphatase activity rates increased by 40 to 100% when adding 50 t DPS ha⁻¹. However, the rates were similar for 50 and 100 t DPS ha⁻¹. It is concluded that DPS promoted microbial growth and activity in the soil by improving C and water availability. However, levelling off of enzyme activity at a DPS application >50 t ha⁻¹ could reflect changes in soil microbial community, or some kinetic interference or nutrient deficiency induced by excessive C input. Reproduced with permission from the CAB Abstracts database.

555. **Aggregation and organic matter decomposition in soils amended with de-inking paper sludge.**

Chantigny, M. H.; Angers, D. A.; and Beauchamp, C. J.

Soil Science Society of America Journal 63(5): 1214-1221.

(Sept. 1999-Oct. 1999)

NAL Call #: 56.9 So3; ISSN: 0361-5995 [SSSJD4]

Descriptors: clay loam soils/ agricultural soils/ land application/ soil organic matter/ degradation/ application rate/ soil aggregates/ soil aggregation/ Quebec/ stability/ paper mill sludge/ silty clay loam soils

Abstract: De-inking paper sludge (DPS) has been traditionally disposed of by burning or landfilling, but could be used as an organic amendment in agricultural soils. Our objective was to assess the impact of DPS incorporation on organic matter and aggregation of a clay loam (Typic Dystrochrept) and a silty clay loam (Typic Humaquept). Whole soil C, particulate (> 53 micrometers) and light

fraction (density < 1.8 Mg m⁻³) C, and water-stable aggregation were measured periodically during a 3-yr period after a single application of DPS at rates of 0 (control), 50, and 100 Mg ha⁻¹). Microscopic observations of water-stable aggregates were also performed. Adding DPS increased whole soil C content, which remained greater than in the control for the duration of the study. After 2 yr, about 40% of the initial material remained in the soil. The proportion of residual C attributed to DPS and present in the particulate fraction remained constant at 70 to 90% during the first 2 yr of the study, whereas the proportion of residual C present in the light fraction decreased from > 95% for fresh DPS to < 50% after 2 yr. One year after incorporation of DPS, the proportion of water-stable aggregates > 1 mm was 2 to 6 times larger in amended soils than in the control. This effect was still statistically significant after 3 yr. Microscopic observations revealed that DPS formed into clusters of wood fibers which became encrusted with mineral particles. We hypothesized that this encrustation provided physical protection to the decaying DPS which remained particulate (> 53 micrometers) in size and progressively densified to > 1.8 Mg m⁻³). As a result, water-stable macroaggregates were formed with DPS as a central core. This citation is from AGRICOLA.

556. Aggregation and organic matter decomposition in soils amended with de-inking paper sludge; Comments on.

Beyer, L. and Mueller, K.
Soil Science Society of America Journal 64(4): 1544-1545. (July 2000-Aug. 2000)
 NAL Call #: 56.9 So3; ISSN: 0361-5995 [SSSJD4].
 Notes: Comment on original article published in *Soil Science Society of America Journal*, 63(5), Sept/Oct, 1999, p 1214-1221 Reply by M Chantigny and D Angers, p 1544-1545.
 Descriptors: clay loam soils/ agricultural soils/ land application/ soil organic matter/ degradation/ application rate/ soil aggregates/ soil aggregation/ stability/ paper mill sludge/ silty clay loam soils
 This citation is from AGRICOLA.

557. Aggregation and organic matter decomposition in soils amended with de-inking paper sludge; Discussion and reply.

Beyer, Lothar; Mueller, Klaus; Chantigny, Martin ; Angers, Denis A.; and Beauchamp, Chantal
Soil Science Society of America Journal 64(4): 1544-1545. (Aug. 2000)
 NAL Call #: 56.9 So3; ISSN: 0361-5995.
 Notes: For reference to original see Chantigny et al., *Soil Sci. Soc. Am. J.*, Vol. 63, p. 1214-1221, 1999.
 Descriptors: aggregate/ carbon/ critical review/ fertilization/ nitrogen/ organic compounds/ sludge/ soil management/ soil treatment/ soils/ soils
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558. Aggregation and organic matter decomposition in soils amended with de-inking sludge; Response to comments on.

Chantigny, Martin; Angers, Denis; and Beauchamp, Chantal
Soil Science Society of America Journal 64(4): 1544-1545. (2000)
 NAL Call #: 56.9 So3; ISSN: 0361-5995

Descriptors: pollution assessment control and management/ soil science/ aggregation/ decomposition/ soil organic matter
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559. Agricultural use of three organic residues: Effect on orange production and on properties of a soil of the 'comarca costa de huelva' (sw spain).

Madejon, Engracia; Burgos, Pilar; Lopez, Rafael; and Cabrera, Francisco
Nutrient Cycling in Agroecosystems 65(3): 281-288. (2003)
 NAL Call #: S631 .F422; ISSN: 1385-1314
 Descriptors: enzymology: biochemistry and molecular biophysics/ horticulture: agriculture/ soil science/ waste management: sanitation/ rutaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ field experiment: applied and field techniques/ organic fertilization: applied and field techniques/ soil sampling: applied and field techniques/ Ec [Electrical Conductivity]/ humic substances/ municipal solid waste compost/ olive mill waste water sludge compost/ organic residues: agricultural use/ pH/ paper mill sludge/ soil chemical properties/ soil enzymatic activity/ soil properties/ soil quality/ total organic carbon
 Abstract: Disposal of urban, agricultural and industrial organic residues implies an increasing problem because of all the economic and environmental repercussions involved. One of the most adequate ways of managing this problem is the agricultural use of these wastes as organic amendments. Three organic residues (AC, olive mill waste water sludge compost; MWC, municipal solid waste compost; and PS, paper mill sludge) were used in a 3-year field experiment involving orange production. The effect of their application on crop production and on soil quality was investigated. Soil samples (0-20 cm depth) collected 11 months after the last soil amendment were analysed for: pH and EC, Kjeldahl-N, available-P, available-K, total organic carbon, humic substances, dehydrogenase, phosphatase, beta-glucosidase, urease and benzoyl-argininamide hydrolysing protease (BAA-protease) activities. Generally, the application of the MWC and PS increased orange yield when compared to control. Moreover, total organic carbon and humic substances significantly increased in soils treated with all the organic amendments. Organic fertilisation increased the Kjeldahl-N and available-P contents of the soil. The application of the organic residues also caused significant increases in dehydrogenase, beta-glucosidase, urease and BAA-protease activities of the soil. Significant positive correlations (p < 0.01) between these enzymatic activities and total organic carbon were found for all treatments. Significant positive correlation between dehydrogenase, urease, beta-glucosidase, and BAA-protease and orange yield was also found. However, a clear inhibition of phosphatase activity was observed in soils treated with PS. The results indicate that the repeated application to the soil of moderate amounts of organic amendments has positive effects on the chemical and biochemical properties of the soil, as well as on the orange yield.
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560. Agronomic utilization of biosolids from pulp and paper mills and other residuals in Quebec: Risk management.

Hébert, M. and Beaulieu, R. Montreal, QC.); pp. 637-649; 2002.

Notes: Sponsors: TAPPI; NCASI; PAPTAC; FSDA.

Descriptors: agronomy / effluents/ odor control/ risk management/ septic tanks/ soil pollution/ soils/ trace elements/ biosolids/ paper and pulp mills/ agronomy/ effluents/ paper mills/ pathogens/ pulp mills/ risk management/ soil/ trace elements

Abstract: The agronomic utilization of residuals is increasing in the province of Quebec (Canada). Indeed, about 2% of farmland is receiving residuals. Biosolids from pulp and paper mills contribute about 65% of the quantities applied on agricultural soils. Fortunately, these biosolids contain few contaminants and are therefore generally classified excellent quality. Research also demonstrated that short-term accumulation of trace elements in soils is nonexistent or negligible. In the long term, loading estimates for metals in soils show values significantly lower than those accepted by the USEPA for municipal biosolids. New risk based analysis done in Quebec suggests also that the risk is very low for highly exposed individuals with contaminants such as cadmium and dioxins and furans. Moreover, the hypothesis of an "unknown contaminant" that could cause irreparable damage, despite the theoretical possibility, is considered to be unlikely according to the international experience with biosolids, and specific utilization criteria used in Quebec. However, although no instance of damage is known, risks reside in illegal spreading of residuals containing pathogens, especially with untreated residuals from septic tanks. Some malodorous biosolids may also pose concerns. The Quebec Ministry of the Environment is developing a new approach to prevent these odor problems.

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561. **Altering soil carbon and nitrogen stocks in intensively tilled two-year rotations.**

Griffin, T. S. and Porter, G. A.

Biology and Fertility of Soils 39(5): 366-374. (2004)

NAL Call #: QH84.8.B46; ISSN: 0178-2762

Descriptors: soil science/ Gramineae: angiosperms, monocots, plants, spermatophytes, vascular plants/ Solanaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ intensive tilling/ soil microbial biomass/ two year rotations: intensive tilling

Abstract: Information is needed on the ability of different crop management factors to maintain or increase soil C and N pools, especially in intensively tilled short crop rotations. Soil samples from field experiments in Maine were used to assess the effect of cover crop, green manure (GM) crop, and intermittent or annual amendment on soil C and N pools. These field experiments, of 6-13 years' duration, were all characterized by a 2-year rotation with either sweet corn (*Zea mays* L.) or potato (*Solanum tuberosum* L.), and primary tillage each year. Total, particulate organic matter (POM), and soil microbial biomass (SMB)-C and -N pools were assessed for each experiment. Total C and N stocks were not affected by red clover (*Trifolium pratense* L.) cover crop or legume GM, but were increased by 25-53% via a single application of papermill sludge or an annual manure and/or compost amendment. With the exception of continuous potato production which dramatically reduced the SMB-C and SMB-N concentration, SMB-C and -N were minimally affected by changes in cropping sequence, but were quite sensitive to amendments, even those that were primarily C. POM-C and -N, associated with the coarse mineral fraction (53-2,000 µm), were more responsive to

management factors compared to total C and N in soil. The change in soil C fractions was a linear function of increasing C supply, across all experiments and treatments. Within these intensively tilled, 2-year crop rotations, substantial C and N inputs from amendments are needed to significantly alter soil C and N pools, although cropping sequence changes can influence more labile pools responsible for nutrient cycling.

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562. **Ammonia volatilization from liquid hog manure amended with paper products in the laboratory.**

Subair, S.; Fyles, J. W.; and O'Halloran, I. P.

Journal of Environmental Quality 28(1): 202-207. (1999)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: amendments/ ammonia/ carbon/ liquid manures/ losses/ newspapers/ nitrogen/ paper/ paper bags/ paper mill sludge/ pH/ pig manure/ piggery effluent/ pulps/ volatilization/ filter paper/ hydrogen ion concentration/ potential of hydrogen

Abstract: Reduction in NH₃ volatilization from liquid pig manure (LHM) by paper bag (PB), filter paper (FP), newsprint (NP), and pulp sludge (PS) added at 2.5 and 5% (fresh LHM weight) was evaluated in a 56 d incubation study. Cumulative NH₃ volatilization ranged between 28 and 53% of initial manure N. When the rate increased from 2.5 to 5%, NH₃ volatilization was reduced by 47, 40, 37, and 29%, respectively, compared to the control. Increasing the rate increased the amount of C lost from the LHM and reduced the net mineralization of organic N. Hence, the addition of organic amendments appeared to have decreased NH₃ volatilization by increasing microbial activity and N immobilization. Liquid pig manure pH was negatively correlated with C loss, indicating that microbial decomposition of paper amendments lowered manure pH but this effect did not appear to be important in controlling NH₃ volatilization. Paper lignin content was not correlated with the loss of C, manure pH, or NH₃ volatilization, suggesting that the effectiveness of paper products in reducing NH₃ volatilization is not controlled by lignin content but rather by other more labile components. Reproduced with permission from the CAB Abstracts database.

563. **Analysis and effect of paper mill effluent on germination and seedling growth of some pulses: *Vigna radiata*, *glycine max* and *cicer arietinum*.**

Joshi, P. K. and Tandon, S.

Journal of Industrial Pollution Control 19(1): 9-13. (2003);

ISSN: 09702083 [JIPCE]

Descriptors: *Cicer arietinum* l-(gram)/ *Glycine max* l-merr (soyabean)/ paper mill effluent/ seed germination/ seedling growth/ *Vigna radiata* l-wilezek (moong)/ effluent/ germination/ growth response/ pulp and paper industry/ seedling/ toxicity/ water pollution/ *Cicer arietinum*/ *Glycine max*/ *Vigna radiata*

Abstract: Paper mills are one of the major sources of water pollution. The industries release colouring materials such as organic dyes/metallic dyes. In this study, the authors have attempted to find the effect of paper mill effluent on germination and seedling growth of three selected crops *Vigna radiata* L. Wilczek (Moong), *Glycine max* L. Merr (Soyabean), and *Cicer arietinum* L. (Gram). For this, the different concentrations of the effluent were made as 0% (control), 25%, 50%, 75% and 100% (pure effluent) in

distilled water. The concentration 25% of the effluent is found good for seedling growth of *Vigna radiata* and *Glycine max* while 50% concentration of effluent is found good for seedling growth *Cicer arietinum*. The present data showed that the concentrations below 50% gave the stimulatory effect on seedling growth of the crops of these pulses while concentrations above 50% is found to be toxic and may cause inhibition in the growth. The germination of these seeds is found in decreasing order as increase in the concentration of the effluent for all these crops.

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564. Application of paper de-inking sludge on soils; Comments on the paper of Fierro, Angers and Beauchamp.

Beyer, L. and Mueller, K.

Soil Biology and Biochemistry 33(3): 413-416. (Mar. 2001)

NAL Call #: S592.7.A1S6; ISSN: 0038-0717 [S BIOAH].

Notes: Discussion of the article "Decomposition of paper de-inking sludge in a sandpit minesoil during its revegetation" by A Fierro, DA Angers, and CJ Beauchamp, this journal, v 32 p 143-150, 2000 Reply by A Fierro, DA Angers, and CJ Beauchamp, p 415-416.

Descriptors: land application/ degradation/ sand/ mined soils/ land restoration/ letters (correspondence)

This citation is from AGRICOLA.

565. Application of paper mill sludge on blueberry: Effects on soil chemical properties and yield.

Lafond, J.; Simard, R. R.; and Roy, M.

In: 1999 Annual Meeting of the Canadian Society of Soil Science..Charlottetown, Prince Edward Island, Canada.); Vol. 79(4).; pp. 644; 1999.

NAL Call #: 56.8 C162

Descriptors: Horticulture: Agriculture/ Nutrition/ Waste Management: Sanitation/ Soil Science/ Ericaceae: Angiosperms, Dicots, Plants, Spermatophytes, Vascular Plants/ Crop Yield/ Paper Mill Sludge: Soil Amendment/ Soil Chemistry/ Abstracts

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566. Application of wastewater from paper and food seasoning industries with green manure to increase soil organic carbon: A laboratory study.

Lin, Chin-Ching; Arun, A. B.; Rekha, P. D.; and Young, Chiu-Chung

Bioresource Technology 99(14): 6190-6197. (2008)

NAL Call #: TD930.A32; ISSN: 0960-8524.

Notes: Publisher: Elsevier Science, The Boulevard Langford Lane Kidlington Oxford OX5 1GB UK, [mailto:nlinfo-f@elsevier.nl], [URL:http://www.elsevier.nl] DOI: 10.1016/j.biortech.2007.12.025

Language: English.

Descriptors: carbon/ combined treatment/ effluents/ food industry/ foods/ industrial wastewater/ laboratories/ manure/ organic carbon/ paper mills/ pulp and paper industry/ soil/ soils (organic)/ waste water/ wastewater/ total organic carbon/ *Oryza sativa*/ *sesbania*

Abstract: This laboratory scale experiment was designed to study the suitability of organic wastes from paper and food seasoning industries to improve the soil organic carbon for rice cultivation. Lignin-rich wastewater from paper industry

and nitrogen-rich effluent from a food industry at suitably lower concentrations were used at two levels of green manure to enhance the soil organic carbon fraction over time. Both the groups of soils with or without *Sesbania* were incubated under submerged condition at 25 degree C for 15 days. Wastewaters from paper industry (WP), food industry (WS), and a combination of WP + WS were added separately to both the treatment groups in flasks. After 103 days of incubation, from all the three treatments and control, total organic carbon and alkali-soluble organic carbon fractions were analyzed. Results indicated that in all the three treatments containing green manure amended with industrial wastewaters, the organic carbon content increased significantly. The alkali-soluble organic carbon fraction was increased by 59% in the soil amended with green manure containing WS and by 31% in the treatment without green manure compared to control. The paper mill waste water namely, WP, increased the organic carbon only in the soil containing green manure by 63%. The combined treatment of WP + WS with green manure increased alkali-soluble organic carbon fraction by 90% compared to control, while in the treatment without green manure, the organic carbon increase was 71%. Overall, the combined treatment WP + WS with green manure could increase the alkali-soluble organic carbon fraction more than all other treatments. Hence, wastewater rich in organics from paper and food industries can be efficiently used to temporarily increase the soil organic carbon content.

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567. Ash fertilization in a clearcut and in a Scots pine stand in central Sweden: Effects on soil water and soil chemistry coupled to laboratory leachings of six ash products.

Ring, E.; Lovgren, L.; Nohrstedt, H. O.; and Jansson, G.

Report SkogForsk 2: 51. (1999); ISSN: 1103-6648

Descriptors: ash/ bark/ clear felling/ fertilizers/ fly ash/ mineral oils/ paper mill sludge/ residues/ soil amendments/ soil chemical properties/ soil chemistry/ soil properties/ soil water/ wood chips/ chemical properties of soil/ clearcutting/ Scotch pine/ Scots pine/ soil moisture

Abstract: The effects of various fly ash products from a Swedish paper mill (PBF) and a pulp mill (CNO) on soil water and chemical properties were investigated in a 2 year scots pine (*Pinus Sylvestris*) stand in Central Sweden. PBF ash was produced by the combustion of bark, wood chips, logging residues and biochemical sludge. CNO originated from the combustion of bark and petrochemical oil. The PBF products were PBF loose, PBF self (self hardened and crushed) , PBF drum (granulated) , PBF disc (granulated) and PBF pellets. The CNO product was pelleted. Data on chemical characteristics, particle size distribution, leaching characteristics off all ash products are tabulated and discussed. The effects of various treatments on soil chemical variables showed only a few significant ($P < 0.05$) effects in clear felled area, and none of the products affected water pH. Nitrate content increased in treatments with PBF self, drum, disc, pelleted and CNO pelleted. Three years after application increased amounts of P were

observed following the application of PBF lose and self, and CNO. PBF drum increased increased Al content in the humus layer and CNO increased pH (in H₂O) from 4.0 to 4.8, and immobilized ammonium.
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568. Assessment of the pulp and paper mill effluent on growth, yield and nutrient quality of wheat (*triticum aestivum* L.).

Singh, A.; Agrawal, S. B.; Rai, J. P. N.; and Singh, P. *Journal of Environmental Biology* 23(3): 283-288. (2002) NAL Call #: QH540.J65 ; ISSN: 02548704 [JEBID]
Descriptors: effluent / plant growth/ pulp and paper mill/ soil texture/ triticum/ carbohydrate/ chlorophyll/ lipid/ protein/ effluent/ growth/ nutritive value/ pulp and paper industry/ soil amendment/ wheat/ yield response/ biomass/ effluent/ grain yield/ paper/ plant growth / plant height/ sand/ soil quality/ wheat/ growth, development and aging/ industrial waste/ physiology/ plant root/ sewage/ water pollutant/ India/ triticum aestivum/ biomass/ carbohydrates/ chlorophyll/ industrial waste/ lipids/ paper/ plant roots/ triticum/ waste disposal, fluid/ water pollutants
Abstract: Assessment of agropotentiality of the effluent coming out from century pulp and paper mill, Ghanshyamdham, Lalkua (Uttaranchal) has been made on wheat (*Triticum aestivum* var. UP-2329) crop grown in two soils differing in texture with different effluent concentrations. Diluted effluent increased the chlorophyll content, plant height, shoot and root biomass, grain yield, protein, carbohydrate and lipid contents in wheat grains, while undiluted effluent caused inhibition in plant growth resulting in a sharp decline of yield. Pure soil provided better growth and yield results than those soil mixed with sand.

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569. Beneficial use of by-product solids from the kraft recovery cycle.

Thacker, W. E.

Ncasi Technical Bulletin(931): 1-36. (2007); ISSN: 08860882 .

Notes: Language of Original Document: French; English.
Descriptors: agricultural limestone/ aox removal/ asphalt/ calcium carbonate/ causticizing/ cement/ ceramic/ concrete/ earthen construction/ green liquor dregs/ green liquor sludge/ land application/ lime grit/ lime mud/ lime sludge/ liming agent/ mine reclamation/ recausticizing/ asphalt/ cements/ concretes/ kraft pulp/ limestone/ paper and pulp industry/ sewage sludge/ lime grit/ liming agents/ mine reclamation/ solid wastes/ asphalt/ calcium carbonate/ causticizing/ concrete/ kraft pulps/ lime stone/ pulp mills/ solid wastes/ white liquor mud
Abstract: Causticizing residues - slaker grits, green liquor dregs, and excess lime mud - are among the significant by-product solids from kraft pulp mills. These materials have chemical and physical properties that can make them suitable for a number of beneficial uses. The predominant use, especially for lime mud, is as a liming agent on agricultural land. Another important use is as a feedstock for cement kilns. Additional uses that have been the subject of research or of limited application for at least one of the causticizing by-products include forest land application, acid mine reclamation, soil stabilization/earthen construction, brick additive, gaseous sulfur-compound

treatment, wastewater neutralization, wastewater AOX removal, sludge bulking control, and asphalt additive. Based on a literature review and contact with kraft mills, this report describes characteristics of causticizing by-products and their possible beneficial uses.
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570. Beneficial use of municipal and industrial wastes in cotton production.

Boquet, D. J.; Breitenbeck, G. A.; and Coreil, C. B. Jr. *Louisiana Agriculture* 42(2): 10-11. (1999); ISSN: 0024-6735

Descriptors: application methods/ ash/ band placement/ composts/ cotton/ crop yield/ fertilizers/ incorporation/ industrial wastes/ loess soils/ nitrogen fertilizers/ paper mill sludge/ refuse/ residual effects/ sewage sludge/ silt loam soils/ soil amendments/ soil properties/ waste utilization/ municipal wastes/ trash/ United States of America
Abstract: In field trials in 1996 on loess silt loam soils at Macon Ridge, near Winnsboro, Louisiana, USA, cotton was given municipal biosolids with or without boiler ash, composted sewage sludge, paper mill sludge or paper mill boiler ash broadcast on the soil surface and incorporated or buried under the crop rows in a 6-inch-wide and 24-inch-deep trench. Control plots were given 80 lb N fertilizer/acre. Residual effects of the treatments were assessed in 1997 and 1998. Cotton fibre yields were increased by all treatments except paper mill sludge. The highest increases were with municipal biosolids, with or without boiler ash, with both application methods. Paper mill sludge gave some yield increases as a residual effect in 1997. Boiler ash was beneficial as a liming material. Application of the waste materials improved soil properties for 3 years. Reproduced with permission from the CAB Abstracts database.

571. Beneficial use of pulp and paper residues for soil amendment in the province of Quebec.

Leclerc, Jacques; Liard, Alain; Villeneuve, Florent; and Desilets, Louis. Vol. 3.

Vancouver, Can: TAPPI Press; pp. 1171-1178; 1998.

Notes: Chapter Number: Norcross, GA, United States.

Descriptors: agriculture/ environmental protection/ forestry/ industrial waste disposal/ land reclamation / laws and legislation/ paper and pulp mills/ sludge disposal/ soil conditioners/ soil amendments/ waste utilization
Abstract: Over the last 3 years, the beneficial use of pulp and paper sludges increased from 3.9% of the total amount generated in the province of Quebec to more than 20%. In early 1994, the Quebec Forest Industries Association (QFIA) formed a sub-committee dedicated to the promotion of the use of pulp and paper residues in agriculture, silviculture, horticulture and reclamation of degraded sites, where landfilling (41.1%) and burning (56.2%) were the most common manners to dispose of all types of residues at that time. Facing a lack of guidelines and standards in that field, the QFIA joined the Quebec Ministry of Environment and Wildlife (MEF) in a government/industry working group with the objective to set a series of criteria and good management practices to facilitate the beneficial use of pulp and paper residues as soil amendments. In 1997, after 3 years, the work in partnership with all interested parties resulted in the characterization of sludges from 45 mills, modeling and monitoring, and pilot and full scale trials. After only one season of experimentation with

the provisional criteria and good management practices, more than 575,000 wet metric tons of residues were beneficially used. This is just a beginning of the total potential use of residues for soil amendments. Some issues are still under discussion with the environmental authorities concerning temporary winter storage in the field and the classification of the sludges according to their potential pathogenic content.

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572. Beneficial use of solid wastes at P. H. Glatfelter company's glatfelter division.

Gingerich Jr., J. C. Denver, CO.); Vol. 1.; pp. 55-60; 2000.

Notes: Conference code: 61635

Sponsors: TAPPI; NCASI; PAPTAC; FSDA.

Descriptors: dewatering/ land fill/ paper and pulp mills/ recycling/ wastewater sludge production/ solid wastes/ drainage/ land fill/ paper mills/ pulp mills/ recycling/ solid wastes

Abstract: The Glatfelter Division of the P. H. Glatfelter Company consists of two millsites; a fully integrated kraft pulp and paper mill in Spring Grove, Pennsylvania and a recycled paper mill in Neenah, Wisconsin. Both facilities produce fine, white papers. Solid waste disposal has been a primary environmental concern for these mills. This has led over the years to varied solutions for minimizing the volume of solid wastes sent to landfills. The most recent concern for Spring Grove has been high calcium waste solids generation: ash from the circulating fluid bed (CFB) power boiler, and excess lime mud from pulp mill lime kiln outages and system purges. For Neenah it has been primary and-secondary wastewater sludge production. The lime content and cementitious properties of dry CFB ash have allowed its development as a soils amendment and conditioning additive, and lime substitute. The moist lime mud has been developed as an agricultural soil conditioner. The dewatered, mixed wastewater sludge is processed into glass aggregate in a thermal plant adjacent to the Neenah mill. This facility was developed and is owned by Minergy Corporation. Ten other area paper mills also have their waste sludges processed through this facility.

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573. Beneficial uses of pulp and paper power boiler ash residues.

Elliott, A. and Mahmood, T.

Tappi Journal 5(10): 9-16. (2006) [TAJOD]

Descriptors: coal ash / fly ash/ paper/ paper and pulp industry/ solid wastes/ wastewater treatment/ chlorinated organics/ wastewater treatment systems/ wood residues/ pulp/ ash/ boilers/ effluent treatment/ electric generators/ land fill/ paper/ paper mills/ pulps

Abstract: Ash residuals generated from recovery and power boilers combusting wood residues, sludges, or auxiliary fuels constitute a major fraction of the solid residues produced by pulp and paper mills. Generation rates in Canada, and likely elsewhere, for ashes of different types have increased substantially since the mid-1990s. Landfilling is the primary disposal method, but there are many potential beneficial applications for these ashes. Large-scale opportunities include land application and construction. Smaller-scale applications exist within both wastewater treatment systems and the papermaking process. Ashes from wood-fired power boilers are generally more suitable for land application than those from coal

combustion, as they contain fewer metals at lower concentrations (except for cadmium). The major benefit of land application arises from the neutralizing properties of ashes, as they provide alkalinity to the soil. Compared to fly ashes, bottom ashes have higher bulk density, lower carbon content and few, if any, dioxins and furans. Land application of ashes produced from salt-laden hog fuels at coastal pulp and paper mills is regulated for dioxins and furans. However, steps can be taken to minimize the generation of such chlorinated organics, making these ashes suitable for land application.

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574. Bioconversion of paper and pulp mill solid wastes.

Mini, K.; Udayasoorian, C.; and Ramaswami, P. P.

Madras Agricultural Journal 86(4/6): 195-198. (1999)

NAL Call #: 22 M262; ISSN: 0024-9602

Descriptors: composts / conversion/ effluents/ fertilizers/ industrial wastes/ manufacture/ paper mill sludge/ sugar factory waste/ Hyphomycetes/ Lentinaceae/ Poriales/ sugar factory effluent

Abstract: Begasse pith (BP) is solid waste discharged from sugarcane bagasse-based paper and pulp industry. It contains high quality of cellulose and lignin. An attempt has been made to convert the bagasse pith into biomanure for land application using activated sludge (AS) and ETP (effluent treatment plant) sludge (ETPS) which are solid wastes obtained from the same factory rich in essential plant nutrients. The AS and ETPS were mixed with BP in different properties to maintain the optimum C:N ratio and nutritional requirement of microorganisms during composting. In order to enhance the composing process, an external source of inocula viz., *Pleurotus sajor-caju* (250 kg), *Trichoderma viride* (0.4%) and a new bacterial culture, EM 4 (500 ml) were added per 100 kg of substrate. NPK content was increased in all treatments and the C:N ratio was reduced to a level suitable for land application within a period of 10 weeks. Mixing BP with AS and ETPS in 2:1:1 ratio produced a better quality compost than mixing BP with AS at 1:1 ratio.

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575. Biological parameters for compost stability assessment and process evaluation.

Lasaridi, K. E. and Stentiford, E. I.

Acta Horticulturae 469: 119-128. (1998)

NAL Call #: 80 Ac82; ISSN: 0567-7572

Descriptors: assays/ assessment/ composting/ composts/ consumption/ evaluation/ germination/ inhibition/ oxygen/ paper mill sludge/ phytotoxicity/ refuse/ regulations/ respirometry/ seed germination/ sludges/ stability/ substrates/ variation/ municipal wastes/ rules/ trash

Abstract: The stability of three composts, representing a variety of substrates (biosolids, refuse, and paper pulp sludge) and composting processes, was assessed through biological and chemical assays. Biological parameters, especially respirometry and germination tests, are more suitable for the evaluation of compost stability, although some chemical parameters (e.g. C:N ratio) are still widely used and even appear in regulations. Three different respirometric parameters were used for the assessment of stability; their common factor is that they all take advantage of the improved technology of the Clark-type polarographic dissolved oxygen probe. The SOUR (specific oxygen

uptake rate) measures the rate of O₂ consumption in an aqueous compost suspension; the TOD₂₀ is the total O₂ consumed by the same suspension in 20 hours; and the DSO_{UR} is the rate of O₂ consumption by a solid compost matrix. The range of values obtained differed for each of three parameter, but they all showed similar variations with composting time, and had highly significant correlations with each other. Cress (*Lepidium sativum*) seed germination, used to evaluate compost stability in terms of phytotoxicity, showed strong inhibition during the thermophilic phase, which subsided later. Of the chemical parameters, the reduction of volatile solids was the most useful, having a highly significant correlation with compost age and the respirometric parameters. The C:N ratio and its variation during composting depended on the type of compost, and was thus of limited usefulness.

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576. A case study of waste management at the northern Finnish pulp and paper mill complex of stora enso veitsiluoto mills.

Nurmesniemi, H.; Pöykiö, R.; and Keiski, R. L. *Waste Management* 27(12): 1939-1948. (2007); ISSN: 0956053X [WAMAE].

Notes: doi: 10.1016/j.wasman.2006.07.017.

Descriptors: acidity/ byproducts/ fluidized beds/ land fill/ paper and pulp industry/ waste management/ green liquor dregs/ hydraulic barrier/ landscaping agent/ wastewater treatment/ acidity/ byproducts/ fluidized beds/ land fill/ paper and pulp industry/ waste management/ wastewater treatment/ landfill/ mill/ pulp and paper industry/ solid waste/ waste management/ wastewater/ water treatment/ chemical waste/ clay/ energy yield/ finland/ forest management/ hydraulic permeability/ landfill/ landscaping/ liquid/ mining/ nonhuman/ paper industry/ priority journal/ pulp mill/ sludge/ soil fertilization/ solid waste management/ waste water treatment plant/ wood debris/ finland/ forestry/ industrial waste/ paper/ refuse disposal/ waste management/ wood/ acidity/ byproducts/ effluent treatment / fluidized beds/ land fill/ pulps/ Eurasia/ Europe/ Finland/ Kemi/ Lappi [Finland]/ Northern Europe/ Scandinavia

Abstract: This work presents the current waste management system at the pulp and paper mill complex of Stora Enso Oyj Veitsiluoto Mills at Kemi, Northern Finland. This paper covers examples of case studies carried out at the mill and describes how the wastes and by-products are utilized as a neutralizing agent for acidic wastewaters (i.e., green liquor dregs from the causticizing process), as a hardener in filling mine cavities (i.e., ash from the fluidized bed boiler), as a landscaping agent (i.e., ash as well as the fibre clay from chemical wastewater treatment plant), as a hydraulic barrier material for landfills (i.e., fibre clay), and as a soil enrichment agent (i.e., calcium carbonate from the precipitated calcium carbonate plant). In addition, the wood waste from the wood-handling plant, sawmill, packaging pallet plant and from the groundwood mill, as well as the biosludge from the biological wastewater treatment plant, are all incinerated in the fluidized bed boiler for energy production. Due to effective utilization of the solid wastes generated at the mills, the annual amount of waste to be disposed of in the landfill has decreased between 1994 and 2004 from 42,990 to 6083 tonn (expressed as wet weight). The paper also gives an overview of the relevant European

Union legislation on the forest industry and on waste management, as well as of the pulping process and of the generation of major solid wastes in the pulp and paper mills. © 2006 Elsevier Ltd. All rights reserved. © 2009 Elsevier B.V. All rights reserved.

577. Changes in cadmium and zinc phytoavailability in agricultural soil after amendment with papermill sludge and biosolids.

Merrington, G. and Madden, C.

Communications in Soil Science and Plant Analysis 31(5-6): 759-776. (2000)

NAL Call #: S590.C63; ISSN: 0010-3624 [CSOSA2]

Descriptors: agricultural soils/ cadmium/ zinc/ heavy metals/ bioavailability/ soil properties/ physicochemical properties/ sewage sludge/ land application/ *Lolium perenne*/ dry matter accumulation/ paper mill sludge

Abstract: The co-disposal of papermill sludge with biosolids is seen as an alternative soil amendment to papermill sludge and inorganic fertilizer. The objectives of this study were to assess the suitability of co-disposal of papermill sludge and biosolids by measuring changes in the soil physicochemical properties and the phytoavailability of cadmium (Cd) and zinc (Zn). Biosolids were applied with papermill sludge as an alternative source of N to inorganic fertilizers at rates calculated on the basis of C:N ratios of the amendments and common papermill sludge disposal practices. Perennial ryegrass (*Lolium perenne* L.) was grown on amended soils for 6 months under glasshouse conditions. The papermill sludge amendment alone increased soil pH and the rate of carbon degradation compared to the control (no amendment) and biosolid co-disposal amendment. There was no difference in dry matter yield per pot of ryegrass between the treatments. Cadmium concentrations in plant tissue increased through the trial with the application of biosolids and papermill sludge. These findings were correlated well with the sorption properties of the soils for Cd as derived from isotherms. However, Zn uptake was unaffected by the application of the papermill sludge and biosolids.

This citation is from AGRICOLA.

578. Changes in copper, lead and zinc concentrations in plants from paper mill sludge-treated soils.

Calace, N.; Petronio, B. M.; Picciolo, M.; Pietrantonio, M.; and Pietroletti, M.

Annali Di Chimica 90(11-12): 655-663. (2000)

NAL Call #: 385 AN7 ; ISSN: 00034592 [ANCRA]

Descriptors: copper/ lead/ metal/ zinc/ barley/ chemistry/ industrial waste/ metabolism/ paper/ pH/ soil/ copper/ hordeum/ hydrogen-ion concentration/ industrial waste/ lead/ metals/ paper/ soil/ zinc

Abstract: Effects of paper mill sludge addition on the availability of metals were studied on different soils both laboratory and naturally polluted; copper, lead and zinc concentrations were determined in *Hordeum Distichum* plants grown on the untreated and on sludge-treated soils. In some case a decrease of metal concentration is observed on sludge-treated soils; these results are consistent with the reduction of metal mobile forms in the soil, before plant growth. The decrease of metal availability in sludge-treated soils may be related with the pH value of the soil after sludge addition.

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579. Changes in soil organic matter, enzymatic activities and heavy metal availability induced by application of organic residues.

Burgos, P.; Madejon, E.; and Cabrera, F. Naples Capri, Italy.; pp. 353-362; 2002.

Descriptors: application rates/ beta glucosidase/ bioavailability/ biological activity in soil/ composting/ composts/ Entisols/ enzyme activity/ heavy metals/ humic acids/ milling byproducts/ organic amendments/ organic carbon/ oxidoreductases/ paper mill sludge/ phosphoric monoester hydrolases/ polluted soils/ proteinases/ refuse/ sandy soils/ sludges/ soil enzymes/ soil fertility/ soil organic matter/ soil pollution/ soil types/ solid wastes/ strawberries/ urease/ humic substances/ municipal wastes/ organic matter in soil/ phosphatases/ proteases/ redox enzymes/ soil quality/ trash

Abstract: A 3-year field experiment on a sandy soil (Typic Endoaquent) in Spain supporting a strawberry (cv, Camarosa) crop was carried out to study the effects of the application of three organic residues (olive mill waste water sludge compost at 10 000 kg/ha, AC; municipal solid waste compost at 48 000 kg/ha, MWC; and paper mill waste at 48 000 kg/ha, PW) on organic matter content, enzymatic activities, and available heavy metals (Fe, Mn, Cu, Zn, Cd, Co, Ni and Pb). Significant increases in organic carbon content (total organic carbon (TOC), total extractable carbon (TEC) and humic acid carbon (HAC)) were observed in soils, depending on the nature of organic amendments. The application of the organic residues also caused significant increases in dehydrogenase [oxidoreductase], phosphatase [phosphoric monoester hydrolases], beta -glucosidase, urease and BAA-protease [proteinase] activities. This favourable effect on soil biological activity was more noticeable in MWC and PW treatments. Significant positive correlation ($P < 0.01$) between enzymatic activities and TOC was found for all treatments. Available heavy metal contents increased slightly in the soils treated with MWC and PW but did not affect negatively soil enzymatic activities. A discriminant analysis generated two functions (F1 and F2) based on linear contributions of the variables (TOC, TEC, HAC, dehydrogenase, phosphatase, beta -glucosidase, urease, and BAA-protease). F1 was correlated with dehydrogenase, TOC and BAA-protease and separated the treatments control (without organic amendments) and AC from PW and MWC. F1 underlined the effect of the higher doses of organic matter applied with MWC and PW. F2 was correlated with humic substances (TEC and HAC), and beta -glucosidase separated treatments C and PW from AC and MWC. This function shows the difference of the effect of composted (AC and MWC) and fresh residues (PW) on soil properties. Results showed that the application of organic residues to a sandy soil improves its agronomic quality by increasing soil organic matter and enhancing soil enzyme activities.

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580. Chemical sequential extraction of heavy metals and sulphur in bottom ash and in fly ash from a pulp and paper mill complex.

Nurmesniemi, H.; Poykio, R.; Kuokkanen, T.; and Ramo, J. *Waste Management Resources* 26(4): 389-99. (Aug. 2008); ISSN: 0734-242X . 18727331

Descriptors: chemical sequential extraction/ heavy metals/ sulphur/ bottom ash/ fly ash/ pulp and paper mills

Abstract: A five-stage sequential extraction procedure was used to determine the distribution of 11 metals (Cd, Cr, Cu, Mo, Pb, Zn, As, Co, V, Ni, Ba), and sulphur (S) in bottom ash and in fly ash from a fluidized bed co-combustion (i.e. wood and peat) boiler of Stora Enso Oyj Oulu Mill at Oulu, Northern Finland, into the following fractions: (1) water-soluble fraction (H₂O); (2) exchangeable fraction (CH₃COOH); (3) easily reduced fraction (NH₂OH-HCl); (4) oxidizable fraction (H₂O₂ + CH₃COONH₄); and (5) residual fraction (HF + HNO₃ + HCl). Although metals were extractable in all fractions, the highest concentrations of most of the metals occurred in the residual fraction. From the environmental point of view, this fraction is the non-mobile fraction and is potentially the least harmful. The Ca concentrations of 29.3 g kg⁻¹ (dry weight) in bottom ash and of 68.5 g kg⁻¹ (dry weight) in fly ash were correspondingly approximately 18 and 43 times higher than the average value of 1.6 g kg⁻¹ (dry weight) in arable land in Central Finland. The ashes were strongly alkaline pH (approximately 12) and had a liming effects of 9.3% (bottom ash) and 13% (fly ash) expressed as Ca equivalents (dry weight). The elevated Ca concentrations indicate that the ashes are potential agents for soil remediation and for improving soil fertility. The pH and liming effect values indicate that the ashes also have a pH buffering capacity. From the environmental point of view, it is notable that the heavy metal concentrations in both types of ash were lower than the Finnish criteria for ash utilization.

This citation is from PubMed.

581. Chemical traits alteration of an acid soil by lime and recycling paper residue application.

Balbinot Junior, A. A.; Torres, A. N. L.; Fonseca, J. A. da; Teixeira, J. R.; and Nesi, C. N.

Revista de Ciencias Agroveterinarias 5(1): 16-25. (2006); ISSN: 1676-9732.

Notes: Original title: Alteracao em caracteristicas quimicas de um solo acido pela aplicacao de calcario e residuos de reciclagem de papel.

Descriptors: acid soils/ aluminium/ base saturation/ boron/ cadmium/ calcium/ cation exchange capacity/ chromium/ copper/ environmental impact/ industrial wastes/ iron/ lead/ lime/ magnesium/ manganese/ mercury/ nickel/ organic amendments/ paper mill sludge/ phosphorus/ potassium/ recycling/ soil acidity/ soil amendments/ soil chemical properties/ soil ph/ soil types/ sulfur/ zinc/ aluminum/ chemical properties of soil/ elemental sulphur/ environmental effects/ Mn/ sulphur

Abstract: The recycling paper process generates residues that are usually placed in embankments. However, these residues present some constituents that can correct soil acidity and act as a source of nutrients, such as calcium. On the other hand, these residues also have heavy metals, which can cause negative environmental impacts. This work aimed to evaluate the effects of doses of lime and two kinds of recycling paper industry residues on the pH_{water}; pH_{SMP}; levels of P, K, M.O., Al, Ca, Mg, Al+H; CTC; saturation by bases and by Al; Ca:Mg ratio; and levels of S, Zn, Cu, B, Mn, Fe, Hg, Pb, Ni, Cd and Cr. The lime and recycling paper residues corrected soil acidity, as well as modified significantly other soil chemical characteristics. The soil K levels were reduced by recycling paper residue

application. Conversely, the application of recycling paper industry residues did not increase the levels of soil heavy metals.

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582. Combined de-inking paper sludge and poultry manure application on corn yield and soil nutrients.

Gagnon, B.; Nolin, M. C.; and Cambouris, A. N.
Canadian Journal of Soil Science 84(4): 503-512. (2004)
NAL Call #: 56.8 C162 ; ISSN: 0008-4271

Descriptors: application methods/ application rates/ crop quality/ crop yield/ Humic Gleysols/ immobilization/ maize/ nitrogen/ nutrient availability/

nutrient uptake/ nutrients/ organic amendments/ organic carbon/ phosphorus/ Podzols/ poultry manure/ precision agriculture/ sandy loam soils/ saturation/ sludges/ soil fertility/ soil organic matter/ soil pH/ soil types/ waste treatment/ watersheds/ catchment areas/ corn/ deinking/ organic matter in soil/ poultry litter/ precision farming/ site specific crop management

Abstract: Application of combined de-inking paper sludge and poultry manure may be an appropriate way to dispose of these residues and restore fertility of highly degraded soils. An experiment was initiated to determine the effects of a single application of this material, using two different application techniques, on corn yield and soil properties of two 12-ha fields of contrasting textures located in the Nicolet watershed in the province of Quebec, Canada. De-inking paper sludge was mixed with poultry manure (PP) at a ratio of 25:1 and strip-applied before corn seeding. The study included three treatments: untreated control, a constant application rate, and variable application rates according to initial soil organic C content. The variable application rates were 10, 20 and 30 Mg dry weight ha⁻¹. The strips were randomized within blocks, and the strips ran lengthwise in the blocks. Soil N immobilization and P release occurred on both sites at least 2 mo after PP incorporation, as measured at the corn eight-leaf and silk apparition stages by the anion-exchange membranes. Despite early N immobilization, grain yield was not affected whereas plant P uptake was increased by PP. At both sites, a single application of PP increased soil pH and major nutrient levels at harvest but had no significant effect on soil organic C. The application of PP also increased P saturation indices but the measured values were well below critical thresholds above which environmental risks would be high. The variable application rate treatment did not differ from the equivalent constant rate treatment for improving soil status and crop growth. This study indicates that mixing de-inking paper sludge and poultry manure may provide a cost-effective and environmentally friendly approach to land disposal of these wastes.

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583. Combined primary/secondary papermill sludge as a nitrogen source in a cabbage-sweet corn cropping sequence.

Simard, R. R.
Canadian Journal of Soil Science 81(1): 1-10. (2001)
NAL Call #: 56.8 C162; ISSN: 0008-4271

Descriptors: ammonium nitrate/ application rates/ cabbages/ crop yield/ Gleysols/ maize/ nitrogen fertilizers/ nutrient uptake/ organic nitrogen/ paper mill sludge/

recovery/ residual effects/ sequential cropping/ soil types / sweetcorn/ Capparales/ corn

Abstract: Combined primary/secondary paper mill sludge (PS) is rich in N and may potentially be used as N source for horticultural crops. A 3-year experiment was conducted at the Joseph-Rheaume research farm of Laval University, located in Ste-Croix de Lotbiniere, Quebec, Canada during 1996-98 to determine the effects of PS application on crop yields, N uptake and N recovery. The PS was applied in 1996 on a Bedford silty clay (Humic Gleysol) cropped to winter cabbage (*Brassica oleracea* var *capitata* cv. Bartolo) at 0, 8, 16, 32, and 64 t ha⁻¹ (dry basis). In 1997, PS was applied at 44% of the 1996 rates to the same plots and cropped to sweetcorn (*Zea mays* cv. Delectable). No PS was applied in 1998 to evaluate residual effects on sweetcorn. Treatments with ammonium nitrate (AN) at 50, 100 and 200% of N fertilizer recommendations were included each year as a reference for crop response. The PS had a C:N ratio of 42:1 in 1996 and of 28:1 in 1997. About 29% of the total N in PS was inorganic. Cabbage and sweetcorn marketable yields and N uptake increased with increasing amounts of PS applied. AN supplemented with PS further increased cabbage yields. Based on the N fertilizer replacement value, the N efficiency coefficient of PS was 44% in the first year. N residual effect of the PS applied in 1996 was observed on the sweetcorn yield in 1997. The two PS applications also had a very significant residual effect on sweetcorn yield in the third year, although supplemental AN at 150 kg N ha⁻¹ tended to further increase yields. The apparent total N recovery by the two crops was similar for PS and AN (i.e., 34 vs. 38%). The apparent recovery of organic N from PS decreased with increasing rates of application from 46 to 25%. These results suggest that PS is an effective source of N for crops and that significant residual N effects should be considered when estimating the N needs of subsequent crops. Reproduced with permission from the CAB Abstracts database.

584. Comparative effectiveness of different organic and industrial wastes on peanut: Plant growth, yield, oil content, protein content, mineral composition and hydration coefficient of kernels.

Basu, M.; Bhadoria, P. B. S.; and Mahapatra, S. C.
Archives of Agronomy and Soil Science 53(6): 645-658. (2007); ISSN: 03650340 .

Notes: doi: 10.1080/03650340701591569.

Descriptors: arachis hypogaea/ farmyard manure/ hydration coefficient/ paper factory sludge/ rice husk ash/ water hyacinth/ arachis hypogaea/ eichhornia crassipes

Abstract: The present study aimed to evaluate the relative efficacy of different organic and industrial wastes, namely, farmyard manure (FYM), water hyacinth (WH) and paper factory sludge (PFS) in combination with chemical fertilizer (CF) along with or without soil amendments like lime or rice husk ash (RHA) on plant growth, yield, mineral composition, oil content, protein content and hydration coefficient of peanut kernels. Results revealed that the integrated application of organic or industrial wastes and CF in conjunction with soil amendments significantly ($p \leq 0.05$) improved the yield and quality of peanut kernels over sole CF. Application of RHA improved the content of P, K, Ca, Mg, Fe, Mn, Zn and Cu. Application of lime under similar combinations decreased the content of Fe, Mn, Zn and Cu, however, improved the content the other nutrients

in kernels. Among three organic sources, PFS was superior against FYM and WH. RHA along with organic wastes and CF improved the yield and quality of peanut kernels in a better and comparable way than lime. Hence, these two industrial wastes (PFS and RHA) could be used as a substitute for FYM and lime, respectively, for improving yield and quality of peanut kernels under acid lateritic soils. © 2007 Taylor & Francis.

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585. Comparative rooting of deciduous landscape shrub cuttings in media amended with paper mill biosolids from four different sources.

Chong, C.; Hamersma, B.; and Bellamy, K. L. *Canadian Journal of Plant Science* 78(4): 519-526. (1998)
NAL Call #: 450 C16; ISSN: 0008-4220

Descriptors: growing media/ ornamental plants/ ornamental woody plants/ paper mill sludge/ perlite/ rooting/ shading/ shoot cuttings/ woody plants/ *Lonicera xylosteoides*/ ornamentals/ potting composts/ *Prunus cistena*/ rooting media/ *Symphoricarpos chenaultii*/ *Viburnum dentatum*
Abstract: The rooting response of stem cuttings from 6 species of deciduous landscape shrub (*Symphoricarpos x chenaultii* cv. Hancock, *Prunus triloba* cv. Multiplex, *Lonicera x xylosteoides* cv. Clavey's Dwarf, *Philadelphus x virginialis* cv. Minnesota Snowflake, *Prunus x cistena* and *Viburnum dentatum*) under mist and 50% shade (outdoor lath) in flats filled with 100% perlite medium, or perlite mixed with 15, 30, 45 or 60% of fresh paper mill biosolids, by volume, from 1 of 4 sources (Atlantic, Domtar, Thorold, and QUNO). The biosolids had little or no adverse effect, despite wide variability in rooting response due to species, source and/or level of biosolids. Regression analyses indicated that, with few exceptions, the percentage rooting, mean root number per rooted cutting, and length of the longest root per cutting increased linearly or curvilinearly, or was unaffected, when regressed over level of biosolids. Optimum amounts of biosolids in the rooting medium ranged from 30 to 60% by volume. The electrical conductivities of the biosolids-amended media were acceptable (0.1-0.3 dS m⁻¹) for rooting of woody cuttings and pore space characteristics were comparable to or better than those of perlite. Reproduced with permission from the CAB Abstracts database.

586. Comparison of chemical methods of assessing potentially available organic nitrogen from organic residues applied to a sandy soil.

Cordovil, C. M. D. S.; Coutinho, J.; Goss, M. J. ; and Cabral, F. *Communications in Soil Science and Plant Analysis* 38(7-8): 989-1006. (2007)
NAL Call #: S590.C63; ISSN: 0010-3624

Descriptors: soil science/ *suidae*: animals, artiodactyls, chordates, mammals, nonhuman vertebrates, nonhuman mammals, vertebrates/ sandy soil/ soil organic matter/ poultry manure/ cambic arenosol/ waste production
Abstract: More than 90% of the nitrogen (N) in soils is bound as organic N compounds. The available N can be estimated on the mineral N released during time-consuming incubations of soil. Several chemical methods have been developed as substitutes for incubations. On the other

hand, there has been an increase in waste production. Residues could potentially offset the need for mineral fertilizers, being both an economic and environmental benefit. Thus, the development of a routine method for prediction of N supply both from soil organic matter (SOM) and the application of organic residues is of great interest. An incubation experiment was performed in a Cambic Arenosol to evaluate different chemical methods. Air-dried soil was mixed with increasing amounts of composted solid municipal waste, secondary pulp-mill sludge, hornmeal, poultry manure, the solid phase from pig slurry, and composted pig manure. Samples were incubated for 244 days under a controlled environment. Among the chemical extractants studied, hot 2 M potassium chloride (KCl) and hot 0.01 M calcium chloride (CaCl₂) showed promise in indicating values of N-0 (potentially available nitrogen), and these simple methods are suitable for use in routine laboratory conditions.

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587. Comparison of microbial indicators under two water regimes in a soil amended with combined paper mill sludge and decomposed cow manure.

Subhasish Tripathy; Pradip Bhattacharyya; Equeenuddin, S. M.; Kim KangJoo; and Kulkarni, H. D. *Chemosphere* 71(1): 168-175. (2008)
NAL Call #: TD172 .C54; ISSN: 0045-6535

Descriptors: acid phosphatase/ Alfisols/ application rates/ application to land/ beta glucosidase/ biological activity in soil/ biological indicators/ cattle manure/ enzyme activity/ lateritic soils/ microbial activities/ organic amendments/ paper mill sludge/ soil amendments/ soil enzymes/ soil flora/ soil types/ sulfuric ester hydrolases/ waste disposal / waste management/ waste utilization/ water holding capacity/ acid phosphomonoesterase/ land application/ microbial biomass/ microbial communities/ soil respiration/ sulfatases/ sulphatases
Abstract: An incubation study was conducted under laboratory conditions to compare the effects of soil amendment of combined paper mill sludge (PS) and decomposed cow manure (DCM) on selected microbial indicators. A lateritic soil (Typic Haplustalf) was amended with 0 (control), 20 or 80 t ha⁻¹ (wet weight) of PS or DCM. The amended soils were then adjusted to 60% water holding capacity (WHC) or submerged conditions, and incubated at 27 degrees C in dark for up to 120 days (d). The microbial biomass C (MBC), the basal soil respiration and the enzyme activities of the beta -glucosidase, acid phosphatase and sulphatase were analyzed at day 15, 30, 45, 60 and 120. Compared to the unamended soil (control), the MBC, the basal soil respiration and the enzyme activities increased with the rate of PS and DCM. At similar rate, the DCM treatment increased significantly the MBC, the soil respiration and the enzyme activities compared to the PS treatment. Also, the water regimes affected the microbial activities. At 60% WHC, the MBC and soil respiration increased during the first 30 d and decreased thereafter. The enzyme activities showed similar trends, where they increased for the first 60 d, and decreased thereafter. In contrast, under submerged condition, the MBC and enzymes activities declined during 120 d, whereas the soil respiration increased. Compared to the control, the used of PS and DCM had no negative impact of

the soil microbial parameters, even at the highest application rate. Long-term field experiments are required to confirm these laboratory results.

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588. Compost effects on soil chemical properties and field nursery production.

Gonzalez, R. F. and Cooperband, L. R.

Journal of Environmental Horticulture 21(1): 38-44. (2003)
NAL Call #: SB1.J66; ISSN: 0738-2898

Descriptors: application to land/ biomass production/ cattle manure/ composts/ crop production/ dry matter/ dry matter accumulation/ electrical conductivity/ growth/ Mollisols/ mulches/ nitrogen/ nutrient availability/ nutrient content / nutrient uptake/ organic amendments/ ornamental plants/ paper mill sludge/ phosphorus/ poultry manure/ sawdust/ shrubs/ silt loam soils/ soil chemical properties/ soil degradation/ soil fertility/ soil organic matter / soil ph/ soil types/ woody plants/ zinc/ chemical properties of soil/ land application/ mulching materials/ organic matter in soil/ ornamentals/ poultry litter/ United States of America

Abstract: Field production of ornamental shrubs results in significant topsoil removal and degradation of soil chemical properties. We amended field soils with compost to evaluate effects on soil chemical properties and shrub biomass production. We applied either duck manure-sawdust (DM), potato cull-sawdust-dairy manure (PC) or paper mill sludge-bark (PMB) composts to a silt loam soil of Madison, Wisconsin, USA, as: (i) incorporated 2.5 cm of compost tilled into the top 15 cm of soil; or (ii) incorporated+mulched 2.5 cm tilled into soil+2.5 cm applied over the soil surface. We grew *Spiraea japonicum* [*Spiraea japonica*] 'Gumball', *Juniper chinensis* [*Juniperus chinensis*] 'Pfitzeriana' and *Berberis thunbergia* [*B. thunbergii*] 'Atropurpurea' seedlings and measured total and plant available nutrients and shrub biomass production and nutrient contents over two growing seasons. Total soil C was 15-21% higher in all mulched treatments compared to incorporated-only and no-amendment control treatments. Total soil N, P and Cu, available P, S, Ca, Mg, K, pH and electrical conductivity increased with increasing TC. Mulched DM compost produced significantly higher DTPA-extractable Zn relative to other treatments. In the second growing season, mulched dry matter (DM) compost produced 39-42% greater total barberry biomass than all other treatments. Among all shrub species, the best soil chemical predictors of plant growth were TC, TS, soluble P, exchangeable Ca and K and DTPA-Zn. The best tissue nutrient-content predictors of plant growth were total shoot N, P and Zn and root Zn. The unique growth response of barberry to mulched DM compost suggests that all shrubs may not respond to compost amendments, particularly over the short term.

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589. Composting by-products from a bleached kraft pulping process: Effect of type and amount of nitrogen amendments.

Das, K. C.; Tollner, E. W.; and Tornabene, T. G.

Compost Science and Utilization 9(3): 256-265. (2001)
NAL Call #: TD796.5.C58 ; ISSN: 1065-657X

Descriptors: amendments/ ammonium nitrate/ bark/ byproducts/ carbon nitrogen ratio/ composting/ paper mill sludge/ poultry manure/ pulp and paper industry/ solid wastes/ sulfate pulping/ kraft process/ kraft pulping/ paper industry/ poultry litter/ sulphate pulping

Abstract: Over 70% of solid wastes (byproducts) generated in the manufacture of paper pulp are presently disposed of in landfills. Most of these byproducts are compostable and reusable in horticulture, landscaping and agriculture. This work addresses the questions of nitrogen amendments required for composting a mix of four bleached kraft pulp mill byproducts - namely, primary sludge, bark, grit and ash. Two nitrogen amendments, ammonium nitrate and chicken litter were compared to determine which provided a more rapid mass reduction and stabilization. Different amounts of ammonium nitrate addition were evaluated to determine if decreasing the C:N ratio of the initial mix (from 130.9 to 28.3) resulted in more rapid composting. A blend of sludge, grit, bark and ash in dry weight percentages of 56, 25, 6 and 13% respectively, stabilized (measured using oxygen respirometry) in a period of 28 days. Although in the initial stages of composting there were differences resulting from the effect of the two types of nitrogen amendments, at the 28th day no significant difference was observed. It was also found that decreasing the C:N ratio did not accelerate the composting process. A composting mix with a C:N ratio of 130.9 had similar mass reduction compared to others with C:N of 95.3, 79.5 and 28.3. Lower C:N ratios were in fact less preferable because of high soluble salt content and greater amendment requirements.

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590. Composting of de-inking paper sludge with poultry manure at three nitrogen levels using mechanical turning: Behavior of physico-chemical parameters.

Charest, M. H. and Beauchamp, C. J.

Bioresource Technology 81(1): 7-17. (Jan. 2002)

NAL Call #: TD930.A32 ; ISSN: 0960-8524 [BIRTEB]

Descriptors: composts / carbon nitrogen ratio/ physicochemical properties/ waste utilization

Abstract: De-inking paper sludge (DPS) is rich in carbon (C) but poor in nitrogen (N). Thus, it has a high C:N ratio which limits the composting process. Accordingly, the goal of this study was to investigate the effect of three N treatments on DPS composting. Compost piles of 100 m³ were formed by mixing raw DPS with poultry manure and chicken broiler floor litter, giving on average 0.6%, 0.7% and 0.9% total N. The changes in physico-chemical parameters, total weight and fiber losses, and maturity of composting piles of DPS were monitored during 24 weeks. The compost piles had a neutral to alkaline pH throughout the study. Inorganic N decreased whereas organic N increased over time for all treatments. These changes in magnitude were different among N treatments resulting in a final total N content of 0.9% for the 0.6% N treatment whereas final total N contents of 0.7% and 0.9% N were measured for the 0.7% and 0.9% N treatments. The total weight, cellulose and hemicellulose losses were higher in 0.6% N treatment giving the lowest C:N ratio after 24 weeks of composting. However, none of the 24 week-old composts of DPS were mature based on their final C:N ratio and colorimetric test of maturity. Except for copper,

their final total trace element contents meet most known standards or guidelines for organic soil conditioners. Overall, 0.6% N treatment was the best to enhance DPS composting using mechanical turning, but a period of more than 24 weeks was required to reach compost maturity. This citation is from AGRICOLA.

591. Composting of pulp and paper mill fly ash with wastewater treatment sludge.

Hackett, G. A. R.; Easton, C. A.; and Duff, S. J. B.

Bioresource Technology 70(3): 217-224. (1999)

NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: composting/ composts/ contaminants/ copper/ dioxins/ fly ash/ phosphorus/ polychlorinated biphenyls/ polycyclic hydrocarbons/ sludges/ sodium/ soil conditioners/ sulfate/ PCBs

Abstract: Waste water treatment sludge and power boiler fly ash were combined and composted in mixed and static windrows 50 m long, 4 m high and 6 m wide. Moisture content was maintained above 50%. The final compost had a pH of 8.5, contained high concentrations of specific nutrients, and an average C:N ratio of 43:1. All metal, PCB, chlorophenol and PAH concentrations were below levels stipulated by local regulations. Over the first 8 weeks of the composting period dioxin concentration decreased by 45% to 41 pg/g TEQ. Leachate tests indicated minimal (<0.1 mg/litre Cu and Pb; <50 mg/litre Na, P, and SO₄-2) leaching of contaminants from the composted material. Application of compost (8 cubic yards/acre) at a sod farm improved soil characteristics as measured by a number of parameters. The dioxin concentration in the final soil/compost mixture was 3 pg/g TEQ, allowing the soil/compost mixture to be classified as agricultural soil. It was concluded that composting produced an acceptable soil conditioner attractive for large volume users of inexpensive soil material (sod farms, golf courses, land reclamation sites). Reproduced with permission from the CAB Abstracts database.

592. Composting short paper fiber with broiler litter and additives. Part I: Effects of initial pH and carbon/nitrogen ratio on ammonia emission.

Ekinci, K.; Keener, H. M.; and Elwell, D. L.

Compost Science and Utilization 8(2): 160-172. (2000)

NAL Call #: TD796.5.C58 ; ISSN: 1065-657X

Descriptors: additives/ aluminium/ ammonia/ byproducts/ carbon nitrogen ratio/ composting/ composts/ decomposition/ emission/ fibres/ losses/ manures/ paper/ pH/ poultry manure/ sawdust/ sulfate/ sulfuric acid/ temperature/ ventilation/ water content/ adjuncts/ aluminum/ fibers/ hydrogen ion concentration/ potential of hydrogen/ poultry litter/ sulphuric acid

Abstract: Short paper fibre (SPF), a byproduct of the paper mill industry, was co-composted with broiler litter (BL) to determine decomposition rate and NH₃N loss as functions of C:N ratio and pH of the compost mixes. The SPF generally had a high C:N ratio >200 while the BL, consisting of bedding material (sawdust) and poultry manure, had a low C:N ratio of 10-12. A total of seven series (27 tests) of pilot-scale studies were conducted using two different SPFs mixed with BL. Additives used for pH control were alum (aluminium sulfate), HiClayReg. Alumina and sulfuric acid. Mixing ratios [SPF/(SPF+BL), kg/kg(dry basis)] used were 0.8 to 0.4. Test conditions were a C:N of 17 to 49, pH of 6.6 to 8.3, initial temperatures of -1 to 22

degrees C, composting temperature of 60 degrees C, water content of 50-55% w.b. and remixing two times per week. Composting temperature was controlled using forced ventilation with a high/low fan setting. Composting trials lasted two weeks. Ammonia loss, O₂, CO₂, compost temperatures and dry solids loss were measured. Evaluations of ammonia emissions vs. initial C:N and pH showed: (1) NH₃-N loss decreased as initial C:N increased, even above a C:N of 38; (2) NH₃-N loss decreased rapidly below pH 7 and increased rapidly for initial pH >8. Addition of alum and/or sulfuric acid decreased NH₃-N loss while HiClayReg. Alumina had little or no effect. Reproduced with permission from the CAB Abstracts database.

593. Control of nitrate leaching from a nitrate vulnerable zone using paper mill waste.

Vinten, A. J. A.; Davies, R.; Castle, K.; and Baggs, E. M.

Soil Use and Management 14(1): 44-51. (1998)

NAL Call #: S590.S68; ISSN: 0266-0032

Descriptors: application rates/ biomass/ denitrification/ depth/ immobilization/ leaching/ nitrate/ nitrogen/ nitrous oxide/ paper mill sludge/ ploughing/ pulp and paper industry/ soil/ tillage/ uptake/ wastes/ Britain/ paper industry/ plowing/ soil cultivation/ United Kingdom

Abstract: The effects on nitrate leaching of incorporation of paper mill waste at three cultivation depths in fields previously cropped to iceberg lettuce and calabrese in Scotland, UK, are reported. In the lettuce experiment, incorporation of 40 t dry matter paper mill waste/ha resulted in a decrease in N leaching (measured with suction cups) from 177 to 94 kg/ha. Deep ploughing with and without paper waste increased N leaching from 105 kg/ha (normal ploughing or surface incorporation) to 172 kg/ha. Measurements of nitrate leaching using deep soil cores showed a less clear cut effect. Nitrous oxide (N₂O) emissions were very high immediately after paper waste was ploughed in to a depth of 35 cm. Non-significant increases in biomass N content were measured in the spring following paper waste application. There was no significant reduction in plant N uptake in subsequent crops. Removal of above-ground crop residues did not have a significant effect on nitrate leaching or N₂O losses. In the calabrese experiment, application of 40 t DM paper mill waste/ha followed by summer cropping with iceberg lettuce caused a decrease in N leaching (measured using deep soil cores) from 227 to 152 kg/ha. Reproduced with permission from the CAB Abstracts database.

594. Cyanide in paper de-inking sludge used as a soil amendment.

Mansfeldt, T.

Journal of Plant Nutrition and Soil Science 164(6): 637-641. (2001)

NAL Call #: 384 Z343A ; ISSN: 1436-8730

Descriptors: cyanides / sludges/ soil amendments/ soil ph/ soil pollution/ solubility

Abstract: Paper de-inking sludge is processed during the recycling of paper, and is sometimes used as a soil amendment. In this study, the effect of a compost application on the cyanide (CN) status in soils of a public park in Germany was investigated. The compost was a mixture of chipped limbs and paper de-inking sludge. Furthermore, the cyanide solubility was studied by

conducting batch experiments with different pH levels. Total cyanide in the amended soils ranged from 540 to 740 mg CN kg⁻¹, and water soluble cyanide from 170 to 370 micro g CN l⁻¹ as determined by means of an aqueous extract. Easily-liberatable cyanides, which include the toxic free cyanide (HCN and CN⁻) and weak metal-cyanide complexes, were not present in the soil. From this result and the fact that iron blue pigments are used during paper printing, it can be inferred that cyanides occurring here were exclusively stable iron-cyanide complexes [Fe(CN)₆]. With increasing pH the solubility of cyanide increased. In contrast to soils of coking plants, in which cyanide occur as Berlin blue, Fe₄[Fe(CN)₆]₃, the cyanide solubility in the paper de-inking sludge amended soils was substantially lower, especially in the neutral and alkaline range. Thus, cyanides in paper de-inking sludge could be present as sparingly soluble metal-cyanide compounds with the general formula A₂B[FeII(CN)₆] with A=K⁺, Na⁺ and B=Ca²⁺ or divalent transition metals and B₂[FeII(CN)₆] with B=divalent transition metals. Pollution exposure by the pathways soil -> human, and soil -> air -> human can be neglected. However, since leaching of iron-cyanide complexes into the ground water cannot be excluded, and since they are decomposed to HCN when exposed to day light, environmental hazards by the pathway soil -> ground water -> surface water are possible. This is the risk arising from paper de-inking sludge applications to soils. Reproduced with permission from the CAB Abstracts database.

595. De-inking sludge and phosphorus effects on growth and symbiotic dinitrogen fixation in forage legumes.

Allahdadi, I.; Beauchamp, C. J.; Califour, F. P. ; Khalaj, H.; and Labafi H. A., M. R.

Pakistan Journal of Biological Sciences 10(14): 2379-2388. (2007)

NAL Call #: QH301 .P355; ISSN: 1028-8880

Descriptors: application rates/ lucerne/ nitrogen fixation/ nutrient uptake/ phosphorus fertilizers/ plant nutrition/ sludges/ alfalfa/ phosphate fertilizers

Abstract: The de-inking process produces a waste by-product, called de-inking paper sludge (DS), that contains paper fibers, clay particles and inks and high carbon (C) concentrations combined with low nitrogen (N) and phosphorus (P) concentrations. The use of high rates of DS to increase the soil organic matter thus requires provision of high rates of N and P for adequate plant growth. Using dinitrogen (N₂)-fixing forage legumes is an alternative to N fertilizer application under such circumstances. In a greenhouse study, DS rates of 0, 50 or 100 Mg/ha and 5 rates of P (40, 80, 120, 160 or 200 kg P₂O₅/ha) were applied to 2 soil types, a clay loam (Pintendre) and a silty clay loam (St-Augustin). N uptake and symbiotic N₂ fixation (SNF) were estimated in lucerne (*Medicago sativa*), sweet clover (*Melilotus officinalis*) and red clover (*Trifolium pratense*), bromegrass (*Bromus inermis*) and lucerne ineffective for N₂ fixation were used as the reference (non-N₂ fixing) crops. Atmospheric N₂ fixation was estimated by natural abundance of 15N (delta 15N). Under controlled conditions, high rates of DS substantially reduced delta 15N values, particularly with high rates of P. In addition, N uptake of legumes generally increased with increased P concentrations and it peaked with 120 or 160

kg P₂O₅/ha. Correlated with the trends observed with delta 15N values, it peaked with 120 or 160 kg P₂O₅/ha. The results showed that under high rates of application of DS and adequate P supply, forage legumes fixed more atmospheric N₂. delta 15N can be a good indicator of SNF under the above-mentioned conditions.

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596. Decomposition of de-inking paper sludge in agricultural soils as characterized by carbohydrate analysis.

Chantigny, M H; Angers, D A; and Beauchamp, C J
Soil Biology and Biochemistry 32(11/12): 1561-1570. (2000)

NAL Call #: S592.7.A1S6; ISSN: 0038-0717

Descriptors: agricultural soils/ analysis/ application rates/ capacity/ carbohydrates/ carbon/ characterization/ clay loam soils/ composition/ decomposition/ deficiency/ dry matter/ fractionation/ Inceptisols/ incorporation/ organic matter/ paper mill sludge/ residues/ sludges/ soil/ soil amendments/ soil fertility/ soil organic matter/ sugars/ transformation/ organic matter in soil/ saccharides
Abstract: Chemical fractionation and carbohydrate characterization to determine the transformation and decay rates of de-inking paper sludge (DPS) in different soils when large loading rates are applied. In a field experiment, DPS was added to a well-drained silty clay loam (Typic Dystrochrept) and a poorly-drained clay loam (Typic Humaquept) at rates of 0 (control), 50 or 100 t dry matter ha⁻¹. Soil samples were obtained periodically during 726 days after sludge incorporation. Soil organic matter was fractionated into hot-water extractable (HWC), mild-acid extractable (MAC) and strong-acid extractable carbohydrates (SAC), and acid-resistant carbon (ARC). The MAC fraction mostly contained hemicellulosic sugars, whereas SAC fraction included most cellulosic glucose. The contribution of microbial saccharides to the different carbohydrate fractions increased during DPS decomposition. The carbohydrate composition indicated that the chemical fractions reflected the net balance between disappearance of sludge carbohydrates and appearance of newly synthesized microbial carbohydrates. The MAC, SAC and ARC fractions in DPS-amended soils, had relative degradabilities of SAC>MAC>ARC. The sludge used, appeared to decompose according to a two-phase pattern, with an initial rapid-decay phase mostly determined by SAC and ARC disappearance (mean residence time 0.1 and 0.3 year, respectively), and a second slow-decay phase: largely characterized by ARC disappearance (mean residence time 8.5 years). DPS decomposed more slowly at the highest application rate, presumably because the capacity of soil microbes to decompose C was temporarily limited by nutrient deficiency. Chemical fractionation and carbohydrate analysis proved useful to study quantitatively and qualitatively the decomposition and transformation of wood-derived residues in agricultural soils.

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597. Decomposition of paper de-inking sludge during revegetation of a sandpit minesoil: A reply to the comments of Beyer and Mueller.

Beauchamp, C. J.; Angers, D. A.; and Fierro, A. 33(3): 415-416. (2001); ISSN: 0038-0717

Descriptors: Waste Management: Sanitation/ Soil Science/ Plantae: Plants/ Paper Industry/ Agriculture/ Ecology/ Paper De-Inking Sludge: Decomposition Mechanisms, Soil Application/ Sandpit Minesoil Revegetation/ Soils: Treatment Method
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598. Decomposition of paper de-inking sludge in a sandpit minesoil during its revegetation.

Fierro, A.; Angers, D. A.; and Beauchamp, C. J. *Soil Biology and Biochemistry* 32(3): 143-150. (Feb. 2000) *NAL Call #:* S592.7.A1S6; ISSN: 0038-0717 [SBIOAH]
Descriptors: disturbed soils/ mined soils/ abandoned land/ land restoration/ *Elytrigia elongata*/ degradation/ carbon/ mineralization/ nitrogen/ phosphorus/ biogeochemical cycles/ Quebec/ paper mill sludge/ organic amendments
Abstract: Paper de-inking sludge was used as an organic amendment for revegetating an abandoned sandpit in Quebec, Canada. In situ patterns of sludge decomposition and of total nitrogen and phosphorus dynamics were characterized in a litter bag study. In a one-time operation, sludge was applied at a rate of 0 or 105 Mg dry matter ha⁻¹, along with N at 3, 6 or 9 kg Mg⁻¹ sludge and P at 0.5 or 1.0 kg Mg⁻¹ sludge. Sludge and fertilizers were incorporated into the top 0.21 m of the minesoil and tall wheatgrass (*Agropyron elongatum* (Host) Beauv.) was seeded. Mass loss was well described by a double exponential model when cumulative degree-days (sum of daily temperature above 0 degrees C) were used as the independent variable. Fifty-one percent of the initial material decomposed with a half life of 0.4 yr, whereas the remaining material had a much slower rate of decay with a half life of 13 yr. The large size and slow decomposition rate of the recalcitrant pool of this material were attributed to the high lignin content and the presence of clay in the sludge. Both N and P in decomposing sludge presented a short accumulation phase followed by a long release phase which likely contributed to the successful revegetation of this disturbed sandpit site.

This citation is from AGRICOLA.

599. Deinking paper fibre application to agricultural land: Soil quality enhancer or copper polluter?

Tandy, S.; Williamson, J. C.; Nason, M. A.; Healey, J. R.; and Jones, D. L. *Soil Use and Management* 24(2): 217-220. (2008) *NAL Call #:* S590.S68; ISSN: 02660032 [SUMAE].
Notes: doi: 10.1111/j.1475-2743.2008.00153.x.
Descriptors: agricultural land/ copper/ paper mill sludge/ soil organic matter/ agricultural land/ copper/ industrial waste/ pH/ pulp and paper industry/ recycling/ soil organic matter/ soil pollution/ soil quality/ soil structure/ England/ Eurasia/ Europe/ United Kingdom/ Wales/ Western Europe
Abstract: Short-fibre paper residuals (deinking paper fibre (DPF) or paper mill sludge) represents a major waste formed during the processing of recycled paper and is known to contain significant quantities of copper. It is often spread onto agricultural land to help increase soil pH and improve structure by adding soil organic matter (SOM). A number of agricultural sites in England and Wales that had received large and repeated applications were sampled to investigate the long-term effects of this practice on soil quality and plant copper content. We found that the composition of DPF waste has changed significantly between 1999 and 2006 with concentrations of Cu

increasing and organic matter content declining. Whilst repeated additions of DPF to agricultural land always increased soil Cu, an associated increase in SOM was not always apparent. There was no link between SOM and bioavailable Cu nor between soil bioavailable Cu and plant Cu. In contrast to previous reports, our findings indicate that improvement in soil quality following the long-term application of DPF was site-specific and in some cases it may have reduced soil quality rather than enhanced it. © 2008 The Authors.

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600. Direct and residual effects of pulp and paper mill sludge on crop yield and soil mineral N.

Vagstad, N.; Broch Due, A.; and Lyngstad, I. *Soil Use and Management* 17(3): 173-178. (Sept. 2001) *NAL Call #:* S590.S68; ISSN: 0266-0032 [SUMAEU]
Descriptors: *Hordeum vulgare*/ *Triticum aestivum*/ crop yield/ soil fertility/ nitrogen/ residual effects/ field experimentation/ carbon nitrogen ratio/ zinc/ manganese/ boron/ copper/ phosphorus/ cadmium/ nitrates/ leaching/ composts/ application rate/ chemical constituents of plants/ Norway/ evaluation/ paper mill sludge
Abstract: Paper sludge composted or stored in static piles for six months was compared to raw and lime-stabilized sludge in a three-year pot experiment (loam) and a four-year field experiment (silt loam) at rates of up to 40 t DM ha⁻¹. The original sludge contained equal amounts of fibre sludge and biological sludge, mixed with bark in 1:1 ratio to improve the structure. The N content in composted sludge (1.30%) was markedly lower than that of the uncomposted piles (1.98%), indicating significant loss during composting. The yield results were generally inversely proportionate to the C:N ratios of the sludges applied. Sludge from the uncomposted piles gave significant grain yield increases in the year following sludge application, while the other sludge types gave variable results. In the residual years there was, generally, a small but positive effect on yield from all the sludge types. The N and P content in grain generally increased with sludge application, but only the higher rates gave statistically significant increases. Sludge application also increased the Zn content in grain, while Mn, B and Cu was less affected. The increase in Cd content was very small.

The 40 t ha⁻¹ sludge rate tended to increase the residual mineral N in soil at the field site and thus the risk of nitrate leaching.

This citation is from AGRICOLA.

601. Dynamic relationships between soil properties and foliar disease as affected by annual additions of organic amendment to a sandy soil vegetable production system.

Rotenberg, D.; Cooperband, L.; and Stone, A. *Soil Biology and Biochemistry* 37(7): 1343-1357. (2005) *NAL Call #:* S592.7.A1S6; ISSN: 00380717 [SBIOA].
Notes: doi: 10.1016/j.soilbio.2004.12.006.
Descriptors: aerial bacteria/ compost/ disease control/ paper mill residuals/ plant available nitrogen/ soil organic matter/ agriculture/ diseases/ fertilizers/ moisture/ nitrogen/ organic compounds/ sand/ soils/ crop diseases/ foliar diseases/ sandy-soil vegetable production/ soil carbon/ crops/ disease prevalence/ sandy soil/ soil property/ agriculture/ diseases/ farm crops/ fertilizers/ moisture/ nitrogen/ organic matter/ soil/ bacteria (microorganisms/)

cucumis sativus/ phaseolus (angiosperm)/ pseudomonas/ pseudomonas syringae pv syringae/ punctum blandianum/ solanum tuberosum

Abstract: Additions of organic amendments to agricultural soils can lead to improved soil quality and reduced severity of crop diseases. However, the relationship between disease severity and soil properties as affected by repeated additions of these amendments is poorly understood. The primary objectives of this study were to (i) resolve multivariate relationships between soil properties and foliar disease severity and (ii) identify soil properties that contribute to disease severity in an intensive irrigated vegetable production system receiving annual additions of fresh and composted paper mill residuals (PMR). Foliar diseases caused by *Pseudomonas syringae* pv. *syringae* on snap bean (bacterial brown spot) and *P. s. pv. lachrymans* on cucumber (angular leaf spot) are the focus of this report. The experiment consisted of a 3-year crop rotation of potato (1998 and 2001), snap bean (1999 and 2002), and cucumber (2000). Treatments included a non-amended fertilizer control and two rates of fresh PMR, PMR composted alone (PMRC), and PMR composted with bark (PMRB). Soil measures included total soil carbon (TC) and nitrogen (TN), particulate organic matter carbon (POMC) and nitrogen (POMN), volumetric soil moisture (VM) and in situ NO₃-N. Multiple regression (MR) and principal component analyses (PCA) were conducted to identify key soil properties that influenced the amount of disease. On average, the amount of TC in plots amended with PMR composts increased 77-178% from 1999 to 2002 compared to the non-amended soils. In 1999, a year in which compost additions reduced the amount of bacterial brown spot of bean, TC explained 42% of the total variation in disease severity in the best MR model. Midseason TN alone was inversely related to angular leaf spot incidence in 2000, while POMN explained 51% of the variation in the best MR model for that year. In 2002, a year in which PMRC-amended soils exacerbated brown spot symptoms, midseason quantities of TN explained 80% of the variation in disease severity. Unique to 2002, NO₃-N alone positively correlated with disease severity. Overall, the influence of soil carbon on disease severity was displaced by the increasing importance of TN and NO₃-N, indicating a transition from a C-dependent to an N-dependent system. © 2005 Elsevier Ltd. All rights reserved. © 2009 Elsevier B.V. All rights reserved.

602. Dynamics of nutrients in tropical acid soils amended with paper pulp sludge.

Voundi Nkana, J. C.; Tack, F. M. G.; and Verloo, M. G. *Waste Management and Research* 17(3): 198-204. (1999) NAL Call #: TD896.W37 ; ISSN: 0734242X [WMARD]. Notes: Chapter Number: Copenhagen K, Denmark doi: 10.1034/j.1399-3070.1999.00006.x. **Descriptors:** cameroon / dynamics/ leaching/ lime/ nutrient balance/ paper pulp sludge/ tropical acid soil/ industrial wastes/ leachate treatment/ organic compounds/ paper and pulp mills/ pH effects/ soil pollution/ dissolved organic carbon/ tropical acid soils/ sludge disposal/ calcium / calcium oxide/ carbon/ carbonic acid/ fertilizer/ magnesium/ nitrate/ rain/ sulfate/ acid soil/ nutrient/ tropical soil/ waste disposal/ cameroon/ nutrient/ paper industry/ priority journal/ recycling/ sludge/ soil treatment/ tropics **Abstract:** Paper mill sludge is characterized by high concentrations of organic matter and lime and very low

concentrations of heavy metals and organic chemicals. Interest in the recycling of paper mill residuals in developing countries is vital because the use of lime and fertilisers by small farmers is financially prohibitive. The effects of paper pulp sludge and lime on the dynamics of soil nutrients was studied in the laboratory using columns of mixed samples of top soil from three tropical acid soils (Kandiudult). The soil columns were leached over a period of 90 days with de-ionized water in amounts equivalent to the annual rainfall of the sampling site. To assess the amount of nutrient that may become available to plants, NH₄OAc-EDTA pH 4.65 soil extractant was used. For all soils, application of paper pulp sludge or lime to tropical acid soils generally resulted in an initial flush and increased concentrations of Ca, Mg, SO₄, dissolved organic carbon (DOC) and inorganic carbon in soil leachates. Compared with liming, application of paper pulp sludge reduced NO₃ leaching. The amount of leached Ca, DOC and inorganic carbon (mainly HCO₃⁻) increased substantially with the addition of paper pulp sludge or lime. In relation to nutrients, the most meaningful amendment effect that persisted after leaching was a substantially increased available Ca in the treated soil. In addition to increasing Ca levels, the addition of paper pulp sludge increased the concentrations of leached and available Ca. To sustain yield increase with paper pulp sludge, calculation of the optimum quantity to be returned to the soil should be based on losses of Ca by leaching and by plant uptake. © 2009 Elsevier B.V. All rights reserved.

603. Dynamics of physical organic matter fractions during de-inking sludge decomposition.

Fierro, A.; Angers, D. A.; and Beauchamp, C. J. *Soil Science Society of America Journal* 63(4): 1013-1018. (July 1999-Aug. 1999) NAL Call #: 56.9 So3; ISSN: 0361-5995 [SSSJD4] **Descriptors:** mined soils/ abandoned land/ disturbed soils/ land restoration/ *Elytrigia elongata*/ degradation/ soil organic matter/ nitrogen/ carbon/ spatial distribution/ mineralization/ nitrogen fertilizers/ phosphorus fertilizers/ nitrate nitrogen/ ammonium nitrogen/ nitrogen content/ soil separates/ application rate/ Quebec/ paper mill sludge/ reclamation/ particle size fractions/ particle density fractions **Abstract:** Replenishment of soil C and N is essential for sustainable revegetation of minesoils. Our study investigated paper de-inking sludge as the organic amendment for revegetating an abandoned sandpit in Quebec, Canada. Sludge was incorporated at 0 (check) and 105 Mg dry matter ha⁻¹ before seeding tall wheatgrass (*Agropyron elongatum* (Host) Beauv.). Nitrogen (at 315, 630 and 945 kg N ha⁻¹) and P (at 52.5 and 105 kg P ha⁻¹) were also applied to all plots. Distribution of C and N was determined periodically in two sizes (< 53 micrometer and > 53 micrometer) and two densities (< 1.8 g cm⁻³) and > 1.8 g cm⁻³) of soil fractions during 823 d. After 823 d, C concentrations were 43 and 69% of those of Day 5, for the low and high N rates, respectively. With time, the proportion of C in the heavy (> 1.8 g cm⁻³) fraction increased from 20 to 55%, but remained near 20% in the fine (< 53 micrometer) fraction. Increasing N rates increased C conservation mainly in the coarse (> 53 micrometer) fraction. The amount of N recovered in all fractions decreased after Day 86, in accordance with a previous litter bag study. Although inorganic N was positively correlated with total N in all fractions, the fine

fraction was the best indicator of the size of the mineral N pool. Addition of sludge to the sandpit favored the restoration of C and N pools, and high levels of mineral N increased this effect. Residues became denser but remained relatively coarse during their decomposition. This citation is from AGRICOLA.

604. Earthworms, mushrooms and zero waste in China.

Pauli, G.

Biocycle 40(2): 68-69. (1999)

NAL Call #: 57.8 C734 ; ISSN: 0276-5055

Descriptors: agricultural wastes/ brewery effluent/ coffee/ composting/ cotton/ crop residues/ edible fungi/ fuels/ husks/ mushroom compost/ mushrooms/ organic wastes/ paper mill sludge/ pulps/ rice/ rice straw/ straw/ tea/ vermiculture/ wastes/ wheat/ farm wastes/ hulls/ paddy

Abstract: The reuse of agro-industrial residues in the mushroom farming region of Qingyuan, China, is described. Mushrooms are grown on agro-industrial wastes including rice straw, coffee hulls, tea residues, cotton seeds, wheat husks, spent grain from breweries and residual fibres from paper processing. The spent substrate from mushroom growing is currently used as a fuel by farmers. However, there is increasing interest in the use of the substrate for growing earthworms, which convert the mushroom protein into humus, with recovery of animal protein.

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605. Earthworms of a land restoration site treated with paper mill sludge.

Pearce, T. G.; Budd, T.; Hayhoe, J. M.; Sleep, D.; and Clasper, P. J.

Pedobiologia 47(5/6): 792-795. (2003)

NAL Call #: 56.8 P343 ; ISSN: 0031-4056

Descriptors: biomass/ copper/ paper mill sludge/ species diversity/ Britain/ United Kingdom

Abstract: Land restoration at a former landfill site, Bidston Moss, NW England, has involved heavy applications of paper mill sludge (PMS), a byproduct of paper recycling. The development of earthworm communities at the site has been assisted by earthworm inoculation. Initially low numbers of epigeic species were present, but as the restoration has progressed since 1996 a substantial number, biomass and diversity of earthworms has become established, including a variety of ecological types. In some areas there is substantial surface casting. Cast colour indicates selective consumption of PMS, and delta 13C ratios suggest that PMS is a major nutrient source for earthworms. Although concentrations of copper in the PMS are higher than those typical for soils, concentrations in earthworm tissue are relatively low. Low availability of copper will reflect the high content of organic matter and clay, and relatively high pH, of the PMS.

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606. Effect of applying paper mill sludge to arable land on soil fertility and crop yields.

Aitken, M. N.; Evans, B.; and Lewis, J. G.

Soil Use and Management 14(4): 215-222. (Dec. 1998)

NAL Call #: S590.S68; ISSN: 0266-0032 [SUMAEU]

Descriptors: Linum usitatissimum/ Hordeum vulgare/

Triticum aestivum/ crop rotation/ field experimentation/ crop

yield/ nitrogen/ nutrient uptake/ soil water content/ heavy metals/ soil pollution/ degradation/ soil fertility/ nitrates/ zinc/ copper/ lead/ mercury/ magnesium/ phosphorus/ potassium/ ammonium nitrogen/ nitrate nitrogen/ land application/ application rate/ ammonium nitrate/ Wales/ sidedressing/ immobilization/ paper mill sludge

Abstract: Two field trials were established in 1991 to determine the effects on crop yield, N uptake, soil moisture content and heavy metal concentration of applying de-inked paper mill sludge (DPMS) over the period 1991 to 1993. In the first year, during decomposition of the DPMS, N immobilization occurred resulting in loss of cereal yield ($P < 0.05$) at low rates of N fertilizer. Approximately 40 kg extra N fertilizer/ha was required per 100t DPMS/ha to compensate for this N immobilization. Soil volumetric moisture content was increased ($P < 0.001$) by c. 20% at both sites by 200 and 300t DPMS/ha. DPMS did not significantly increase ($P > 0.05$) soil concentrations of total Zn, Cu and Pb. Soil nitrate concentrations after harvest were reduced ($P < 0.01$) by c. 17 mg N/kg per 100t DPMS/ha with increasing rates of DPMS up to 200t/ha. In the second year following the DPMS application, there were no significant effects on grain yield indicating that very little or no N was immobilized. By the third year, the soil N supply was 7 kg N/ha higher where a single dressing of 100t DPMS/ha had been applied compared to the control. This resulted in an overall yield increase of 7% ($P < 0.10$). Soil N supply was lower (N.S.) but crop yields were similar ($P > 0.05$) to the control where single dressings of 200 and 300t DPMS/ha had been applied. This citation is from AGRICOLA.

607. Effect of cellulose residues and manure in the soil on the development of corn (Zea mays) and bean (Phaseolus vulgaris).

Costa, A. S. V. da; Rufini, J. C. M.; Silva, M. B. da; Galvao, E. R.; and Ribeiro, J. M. O.

Revista Ceres 54(314): 339-344. (2007)

NAL Call #: 9.2 C332; ISSN: 0034-737X.

Notes: Original title: Efeito do residuo de celulose e esterco no solo sobre o desenvolvimento do milho (Zea mays) e feijao (Phaseolus vulgaris).

Descriptors: cellulose/ dry matter/ maize/ manures/ paper mill sludge/ plant development/ plant parts/ recycling/ roots/ corn/ green bean/ snap bean

Abstract: One of the main concerns on the use of industrial residues of recycled paper is the amount of produced solid residues. A study was conducted in Brazil to evaluate the effects of cellulose solid residues from paper mill in the development of bean and maize. Cellulose residue was incorporated into the soil alone or combined with manure at different proportions. The plants were sown immediately after incorporation of the mixtures of cellulose and manure in the soil and at 40 days post-incorporation. The plants were evaluated at 40 days post-germination using dry matter of the aerial part and roots. The increase in cellulose residue in the soil caused a significant drop in dry matter production of maize plants upon planting immediately after incorporation. Following a period of stabilization in the soil, these negative effects were less apparent in root development. The bean plants had the roots less affected by cellulose residues in the two tested conditions, which was not found for the aerial parts.

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608. Effect of cellulose wastes upon the growth of *Phragmites australis*.

Jordan, M.; Wilken, D.; Gerth, A.; and Munoz, O.
International Journal of Phytoremediation 10(3): 195-207.
(2008)

NAL Call #: TD192.75 .I58; ISSN: 1522-6514

Descriptors: ash/ benzyladenine/ boron/ cellulosic wastes/ chlorosis/ copper/ fly ash/ growth/ heavy metals/ in vitro regeneration/ industrial wastes/ iron/ manganese/ metal tolerance/ micropropagation/ phytoremediation/ plant growth regulators/ sludges/ sodium/ solid wastes/ uptake/ benzylaminopurine/ bioaccumulation/ Mn/ plant growth substances/ plant hormones

Abstract: Growth responses of *Phragmites australis* (Cav.) Trin. Ex Steud. (reed grass), a helophyte species, were examined under in vitro and greenhouse conditions in the presence of various residues from a Kraft pulp mill. Plant tolerance to solid residues (ashes, dregs, flyashes, grits, primary sludge, and brown stock rejects) was tested in vitro. Solid residues were added separately up to 30% (w/v), as well a liquid residue up to 30% (v/v), to a Murashige and Skoog (1962) sucrose-free nutrient media with (5 mg l⁻¹) 6-benzylaminopurine. After 2 mo in vitro, plantlets developed well in the presence of up to 10% solid or liquid wastes, but higher concentrations of either limited growth. This effect was mainly attributed to the plant's uptake and accumulation of various elements such as sodium, iron, copper, manganese, and boron, which are common to these waste types, thus showing an efficient phytoremediation potential. When added to MS media, the concentration of these elements generally decreased in the residual media after 2 mo of culture: the initial sodium, iron, and copper content in the growth media was reduced ca. 10-fold detected; a 5-fold reduction occurred for manganese and boron. In experiments under greenhouse conditions with in vitro propagated plantlets potted in mixtures of a commercial organic soil and residues, significant differences in plant development (plant size and fresh weight increase) were observed in the presence of ashes mixed at levels of 20% and 30%, compared to the control in organic soil. For other solid wastes, plant growth was inhibited as the concentration of each waste increased, causing chlorosis and/or plant necrosis.
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609. Effect of de-inking paper sludge compost application on soil chemical and biological properties.

Baziramakenga, R.; Simard, R. R.; and Lalonde, R.
Canadian Journal of Soil Science 81(5): 561-575. (2001)
NAL Call #: 56.8 C162 ; ISSN: 0008-4271

Descriptors: application rates/ composts/ enzyme activity/ magnesium/ paper mill sludge/ phosphoric monoester hydrolases/ phosphorus fertilizers/ Podzols/ potassium/ potatoes/ poultry manure/ soil chemical properties/ soil enzymes/ soil ph/ soil properties/ soil types/ soil water content/ urease/ chemical properties of soil/ green bean/ inorganic nitrogen/ phosphatases/ phosphate fertilizers/ poultry litter/ snap bean

Abstract: A 2-year field study evaluated the effect of applying compost of de-inking paper residues and poultry manure (DSPC) on the chemical and biological properties of Tilly silt loam (Gleyed Humo-Ferric Podzol) in Sainte-

Croix de Lotbiniere, Quebec, Canada. The experiment began in 1996 with snap bean (*Phaseolus vulgaris*) and continued in 1997 on the same plots with potato (*Solanum tuberosum*). In 1996, treatments included three rates of mineral fertilizer (MF) (60, 120 and 180 kg P₂O₅-K₂O ha⁻¹), three rates of DSPC (14, 28 and 42 Mg ha⁻¹ on a dry matter basis) alone or in combination with MF, and an untreated control. In the spring of 1997, main plots were divided into four subplots and P fertilizer was applied at 0, 44, 88 and 132 kg ha⁻¹. The DSPC increased soil pH and water content. Soil inorganic N increased just after DSPC application, but this effect lasted only 1 year. Soil Mehlich-3 extractable P showed a significant increase due to DSPC application and the increase was much larger when DSPC was applied in combination with P fertilizer. Soil phosphatase [phosphoric monoester hydrolases] and urease activities were also increased by DSPC. Application of DSPC increased soil Mehlich-3 extractable K and Mg contents. Except for Mn and Zn, soil Mehlich-3 extractable heavy metal contents were not influenced by DSPC. This experiment indicates that compost derived from a mixture of de-inking papermill sludges and poultry manure is a potential source of nutrients for crops and can effectively improve chemical and biological properties of low fertility or degraded soils.

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610. Effect of deinking paper sludge compost on nutrient uptake and yields of snap bean and potatoes grown in rotation.

Baziramakenga, R. and Simard, R. R.
Compost Science and Utilization 9(2): 115-126. (2001)
NAL Call #: TD796.5.C58 ; ISSN: 1065-657X

Descriptors: application rates/ composting/ composts/ crop yield/ nutrient availability/ nutrient uptake/ paper mill sludge/ phosphorus/ phosphorus fertilizers/ plant nutrition/ Podzols/ potassium/ potatoes/ poultry manure/ residual effects/ rotations/ silt loam soils/ soil types/ crop rotation/ green bean/ phosphate fertilizers/ poultry litter/ rotational cropping/ snap bean

Abstract: A field study was conducted on a tilly silt loam (gleyed Humo-Ferric Podzol) located in Sainte-Croix de Lotbiniere, Quebec, Canada, in 1996 and 1997, to evaluate the effects of compost application on P and K uptake, and yield of snap bean (*Phaseolus vulgaris* cv. Centralia) and potatoes (*Solanum tuberosum* cv. Gold Rush). The compost was derived from a mixture of de-inking paper residues and poultry manure (DSPC). Treatments used were three rates of DSPC (14, 28 and 42 t ha⁻¹ on a dry matter basis) alone or in combination with mineral fertilizer (MF), three rates of MF (60, 120 and 180 kg P₂O₅-K₂O ha⁻¹), and an untreated control. In 1997, P fertilizer was applied in subplots at 0, 100, 200 and 300 kg P₂O₅ ha⁻¹. Snap bean yield increased significantly with both DSPC and MF application. Apparent P and K recoveries from MF by snap bean decreased with DSPC or MF rate. In combination with DSPC, P and K recoveries from MF by snap bean were smaller at all rates than those with no DSPC. Based on nutrient uptake, P and K in DSPC were more available than in MF. Potato yield in the following year was not significantly influenced by the treatments nor by supplemental P fertilizer added in the second year. Results

indicate that compost derived from a mixture of de-inking papermill sludges and poultry manure is a potential source of P and K for crops and could increase crop yield. Reproduced with permission from the CAB Abstracts database.

611. Effect of FYM, CaCO₃ and paper mill sludge on some physical properties of an acidic Alfisol of Central Brahmaputra Valley Zone of Assam.

Sarma, P. K.; Bordoloi, P. K.; and Bora, N.

Crop Research Hisar 20(1): 81-86. (2000)

NAL Call #: SB4.C66 ; ISSN: 0970-4884

Descriptors: Alfisols / bulk density/ hydraulic conductivity/ paper mill sludge/ rain/ soil amendments/ soil physical properties/ soil strength/ physical properties of soil/ rainfall
Abstract: A laboratory investigation was conducted for the improvement of physical attributes of an acidic Alfisol of the rain shadow belt of Central Brahmaputra Valley Zone of Assam, India, with unfavourable soil physical properties (wide crack pattern, high bulk density and low hydraulic conductivity) by using proven aggregating agents, FYM and CaCO₃ along with paper mill sludge (PMS) (CaCO₃=90%, Ca(OH)₂=1-2%, NaOH=1-2% and Silica=4.5%) produced as waste product at Hindustan Paper Corporation Limited, Jagiroad, Nagaon. Results showed that the aggregating agents modified the crack pattern in terms of increased number of cracks m⁻² in the smaller size range. Number of cracks m⁻² exhibited positive correlation with mean weight diameter (MWD), macroaggregate and microaggregate of 20-50 and 50-250 micron size range. The correlation was negative with microaggregate of 2-20 micron and clay size particle of <2 micron. Reduction in microaggregate and increase in macroaggregate observed was a result of aggregating agent addition. Higher values of MWD were observed where FYM+CaCO₃ and FYM+PMS were applied in combination. Bulk density correlated positively with <2 micron particle 2-20 micron size microaggregate and negatively with 20-50 and 50-250 micron aggregate. Water holding capacity correlated negatively with bulk density. Reproduced with permission from the CAB Abstracts database.

612. Effect of industrial effluents on growth and development of earthworms.

Karabhantanal, S. S. and Awaknavar, J. S.

Journal of Ecotoxicology and Environmental Monitoring 15(4): 301-307. (2005); ISSN: 0971-0965

Descriptors: biological development/ factory effluents/ growth/ industrial effluents/ industrial wastes/ paper mill sludge/ soil amendments/ soil fauna / soil invertebrates/ sugar factory waste/ toxicity/ Mysore/ sugar factory effluent
Abstract: Effluents were collected from sugar, polyfibre and paper mills in Karnataka, India, to assess their toxicity on earthworms. Among the mills, effluents from the polyfibre mill recorded high toxicity to earthworms as the lowest LC₅₀ value under laboratory condition was obtained for both juveniles (38.8%) and adults (44.3%). In pot culture condition, all effluent treated pot recorded significantly the lowest length (14.7, 11.8 and 6.4 cm), weight (929.4, 993.3 and 418.4 mg) of earthworms at 45 DAR in sugarcane, paper and polyfibre mills, respectively, compared to untreated pot, which recorded 16.9, 15.9 and 9.29 cm of length and 1010.8, 1230.2 and 601.6 mg of weight at corresponding mills. Similarly, cocoon production per worm

was highest in the pots without effluents (60.3, 54.5 and 45.5) compared to pot with effluent (50.3, 41.1 and 34.4) in sugarcane, paper and polyfibre mills, respectively. However, no significant difference was observed between the treated and untreated pots in terms of tomato yield per plant. The toxicity pattern of effluents to earthworms were polyfibre > paper mill > sugar factory. Reproduced with permission from the CAB Abstracts database.

613. Effect of lime on sabaigrass based intercropping system in slopy lands.

Tripathy, S. K.; Mohapatra, S.; Sahoo, S.; and Sahu, S. K. *Range Management and Agroforestry* 26(2): 116-119. (2005); ISSN: 0971-2070

Descriptors: acid soils/ biomass production/ black gram/ cost benefit analysis/ cowpeas/ crop yield/ cropping systems/ green gram/ intercropping/ lime / lime requirement/ liming/ liming materials/ nitrogen/ nitrogen content/ nutrient uptake/ organic amendments/ paper mill sludge/ phosphorus/ potassium/ returns/ sloping land/ soil acidity/ soil amendments/ soil fertility/ soil types/ black eyed peas/ mung bean/ southern peas
Abstract: Field experiment was conducted at the research farm of the Orissa University of Agriculture and Technology, Chhenahua, India, to investigate the effect of lime on the biomass yield of sabaigrass (*Eulaliopsis binata*). Paper mill sludge containing 75% CaCO₃ was used as liming material. It was applied at half the lime requirement (LR=4 t/ha) 10 days before sowing in moist soil. The experiment was initiated in July 2001 with four cropping treatments, namely: sole sabaigrass (S); sabaigrass+green gram (S+GG) in 1:2 row ratio; sabaigrass+black gram (S+BG) in 1:2 row ratio; and sabaigrass+cowpea (S+C) in 1:1 row ratio compared under control and lime application. Results showed that the average annual dry matter production of sabaigrass ranged from 4.89 to 28.63 q/ha in control plots and from 5.66 to 37.65 q/ha in plots limed at 0.5 LR. Sole sabaigrass produced higher dry matter yield (6.11 to 41.05 q/ha) than inclusion of legumes as the intercrop in between sabaigrass. Cowpea produced the maximum seed yield amounting to 4.64 and 2.94 q/ha during 2001 and 2002, respectively. Nitrogen concentration in grass under sole planting was low but its uptake was maximum due to accumulation of higher biomass. Sabaigrass in association with green gram showed higher N uptake than the other legumes. The maximum net returns Rs10 663/ha was obtained under intercropping of green gram with sabaigrass in limed plot. Reproduced with permission from the CAB Abstracts database.

614. The effect of mixing organic biological waste materials and high -N crop residues on the short -time N₂O emission from horticultural soil in model experiments.

Chaves, B.; Neve, S. de; Cabrera, M. del C. L.; Boeckx, P.; Cleemput, O. van; and Hofman, G.

Biology and Fertility of Soils 41(6): 411-418. (Aug. 2005) NAL Call #: QH84.8.B46; ISSN: 0178-2762

Descriptors: horticultural soils/ sandy loam soils/ nitrous oxide/ gas emissions/ celery/ crop residues/ organic wastes/ soil amendments/ pulp and paper sludge/ straw/ sawdust/ yard waste composts/ nitrate nitrogen/ leaching/ tannins

Abstract: Manipulating the N release from high-N crop residues by simultaneous mixing of these residues with organic biological waste (OBW) materials seems to be a possible method to reduce NO₃- leaching. The aim of this study was to examine whether the incorporation of OBW materials together with a high-N crop residue (celery) had also an effect on N₂O emission from horticultural soil under short-term and optimised laboratory conditions. A sandy loam soil and celery residues were mixed with different OBW materials and brought into PVC tubes at 80% water-filled pore space and 15pC. Every 2.5 h, a gas sample was taken and analysed by gas chromatography for its N₂O concentration. The soil amended with only celery residues had a cumulative N₂O emission of 9.6 mg N kg⁻¹ soil in 50 h. When the celery residues were mixed with an OBW material, the N₂O emission was each time lower than the emission from the celery-only treatment (between 3.8 and 5.9 mg N kg⁻¹ soil during maximum 77 h), except with paper sludge (17.2 mg N kg⁻¹ soil in 100 h). The higher N₂O emission from the paper sludge treatment was probably due to its unusually low C:N ratio. Straw, green waste compost 1 (GWC1) and 2 (GWC2), saw dust, and tannic acid reduced the N₂O emission of the celery treatment by 40 to 60%. Although the N₂O reduction potential can be expected to be lower and with differing dynamics under field conditions, this study indicates that apart from reducing NO₃- leaching, OBW application may at the same time reduce N₂O emissions after incorporation of high-N crop residues.

This citation is from AGRICOLA.

615. Effect of organic amendments on soilborne and foliar diseases in field-grown snap bean and cucumber.

Stone, A. G.; Vallad, G. E.; Cooperband, L. R.; Rotenberg, D.; Darby, H. M.; James, R. V.; Stevenson, W. R.; and Goodman, R. M.

Plant Disease 87(9): 1037-1042. (2003); ISSN: 0191-2917
Descriptors: cucumbers/ cultural control/ fungal diseases/ organic amendments/ paper mill sludge/ plant diseases/ plant pathogenic bacteria/ plant pathogenic fungi/ plant pathogens/ potatoes/ Coelomycetes/ gherkins/ green bean/ Peronosporomycetes/ phytopathogens/ Pythiaceae/ Saprolegniaceae/ snap bean/ Straminipila/ United States of America

Abstract: Several paper mills in Wisconsin have programs for spreading paper mill residuals (PMR) on land. A growing number of vegetable farmers recognize the agronomic benefits of PMR applications, but there have been no investigations on the use of PMR for control of vegetable crop diseases. Our objective was to determine the effect of PMR amendments on soilborne and foliar diseases of cucumber and snap bean grown on a sandy soil. Raw PMR, PMR composted without bulking agent (PMRC), or PMR composted with bark (PMRBC) were applied annually in a 3-year rotation of potato, snap bean, and pickling cucumber. Several naturally occurring diseases were evaluated in the field, along with in situ field bioassays. All amendments suppressed cucumber damping-off and Pythium blight and foliar brown spot of snap bean. Both composts reduced the incidence of angular leaf spot in cucumber. In a separate field experiment planted with snap bean for two consecutive years, all amendments reduced common root rot severity in the second year. In a greenhouse experiment, the high rate of PMRBC

suppressed anthracnose of snap bean. These results suggest that the application of raw and composted PMR to sandy soils has the potential to control several soilborne and foliar diseases.

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616. Effect of paper mill effluent on germination of agricultural crops.

Dhevagi, P. and Oblisami, G.

Journal of Ecobiology 12(4): 243-249. (2000)

NAL Call #: QH540.J56 ; ISSN: 0970-9037

Descriptors: black gram/ castor beans/ germination/ green gram/ groundnuts/ growth/ irrigation/ irrigation water/ maize/ nutrients/ paper mill sludge/ sesame/ soybeans/ sunflowers/ waste water/ beniseed/ corn/ Madras/ mung bean/ peanuts/ soybeans/ watering

Abstract: Industrial waste water is being used for irrigation in dry areas. These effluents not only contain nutrient that enhances the growth of crop plants but also have other toxic materials. An experiment was carried out to study the effect of paper mill effluent on germination and growth behaviour of crops like maize, groundnut, sunflower, soybean, black gram, green gram, gingelly [sesame] and castor beans in Tamil Nadu, India [date not given]. The effluent analyses showed the presence of low concentration of major inorganic nutrients. The results obtained after the germination study showed that raw effluent affected the germination percentage of maize, groundnut, soybean and black gram by 19, 5.4, 13, and 9.9%, respectively. The highest reduction in vigour index was observed in castor beans (56.5%) and gingelly (47.6%). Growth behaviour of the crops showed increasing trend towards increase in dilution of the effluent.

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617. Effect of paper mill effluent on seed germination and seedling growth of six varieties of groundnut (arachis hypogaea).

Sundaramoorthy, P. and Kunjithapatham, J.

Journal of Ecotoxicology & Environmental Monitoring 10(1): 53-57. (Jan. 2000); ISSN: 0971-0965

Descriptors: alkalinity/ biochemical oxygen demand/ growth/ industrial effluents/ paper industry wastes/ plant physiology/ pulp and paper industry/ seedlings/ toxicity testing/ trees/ wastewater analysis/ wastewater disposal/ Arachis hypogaea

Abstract: To find the effect of paper mill effluent on six varieties of groundnut (*Arachis hypogaea*), different concentrations (10,25,50,75 and 100%) of paper mill effluents were selected and germination experiments were carried out. Paper mill effluent was alkaline in nature and it contained higher amount of suspended and dissolved solids which resulted in high Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The seed germination percentage, seedling growth and their dry weight were taken into consideration for varietal screening experiment. These parameters were found to decreased with the increase of effluent concentrations. On the basis of data obtained from germination studies, the variety CO.2 showed the lowest percentage decrease over control values (34%, 57.5% and 24% for seed germination, seedling growth and seedling dry weight) than the other varieties studied for paper mill effluent treatment.

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618. Effect of paper mill effluent on soil properties and performance of maize in Mollisols of Uttaranchal.

Singh, A. P. and Room Singh
Journal of the Indian Society of Soil Science 53(2): 267-269. (2005)

NAL Call #: 56.9 IN2; ISSN: 0019-638X

Descriptors: biomass production/ clay loam soils/ electrical conductivity/ growth/ irrigation/ maize/ Mollisols/ nitrogen/ nutrient availability/ nutrient uptake/ organic carbon/ paper mill sludge/ phosphorus/ plant height/ plant nutrition/ potassium/ pulp mill effluent/ sandy loam soils/ seed germination/ soil bacteria / soil fertility/ soil fungi/ soil organic matter/ soil ph/ soil types/ waste disposal/ waste management/ waste utilization/ corn/ kraft mill effluent/ organic matter in soil/ watering

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619. Effect of paper mill effluent on spermosphere microflora.

Dhevagi, P.; Rajannan, G.; and Oblisami, G.
Journal of Ecobiology 12(2): 149-152. (2000)

NAL Call #: QH540.J56 ; ISSN: 0970-9037

Descriptors: effluents/ green gram/ groundnuts/ maize/ microorganisms/ paper mill sludge/ soyabeans/ sunflowers/ corn/ micro organisms/ mung bean/ peanuts/ soybeans/ spermosphere

Abstract: An experiment studied the effect of treated paper mill effluent on spermosphere microflora of maize, sunflower, green gram [*Vigna radiata*], black gram [*V. mungo*], soyabean and groundnut. The effluent used was light brown in colour with alkaline pH having an EC of 0.36 dS m⁻¹. The treated effluent had a good amount of hardness, bacteria, actinomycetes and fungi. The population of spermosphere microflora was lower (4.1 to 95.7x10⁶/g of soil) at higher concentration (100%) of treated effluent irrigation; whereas higher counts (104.1x10⁶/g of soil) were recorded at lower effluent concentration (50%).

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620. Effect of paper sludge application on carbon dynamic in two soils from Valencia lake basin (Venezuela) .

Martinez, Y. and Rivero, C.
Revista de la Facultad de Agronomia, Universidad Central de Venezuela 32(1): 41-52 . (2006); ISSN: 0041-8285.

Notes: Original title: Efecto de la aplicacion de lodos papeleros sobre la dinamica del carbono en dos suelos de la Cuenca del Lago de Valencia.

Descriptors: agricultural soils/ biological activity in soil/ carbon dioxide/ microbial activities/ organic carbon/ sludges/ soil types

Abstract: An experiment was carried out at the Biology and Fertility greenhouse of Facultad de Agronomia of the Universidad Central de Venezuela, during 66 days to evaluate organic C dose, culture presence and time. The first centimetres of the profile of two representative agricultural soils from the Valencia lake basin were used.

The organic carbon was determined by humid oxidation and the soil respiration by capture of the CO₂ produced with NaOH trap. The content of organic carbon did not show significant differences in the treatments with and without cultivation, neither any tendency with the time. The quantity of produced C-CO₂ in both soils was dependent of the treatment. The highest production in C-CO₂, in the first stages, was observed in the Guacara soil, with rapid and higher mineralization.

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621. The effect of pulp unit effluent on agriculture.

Sundari, S. and Kanakarani, M. S. P.
Journal of Industrial Pollution Control 17(1): 83-97. (2001); ISSN: 09702083 [JIPCE]

Descriptors: crop production/ ground water/ land value/ plant diseases/ pulp industry effluent/ rehabilitation/ soil quality/ agricultural application/ pulp and paper industry/ waste management/ wastewater/ India

Abstract: In this study an attempt is made to assess the impact of pulp unit wastewater discharge on the environment particularly agriculture. The analysis shows that the partially treated effluent has adversely affected the ground water resources, soil fertility, crop production, land value and has also resulted in the death of livestock. As the partially treated effluent is not adequate to safeguard the environment, the pulp industry should go in for that technology that would ensure 100% treatment of wastewater. The government should assist the industry in the acquisition of the technology for complete treatment of the wastewater.

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622. Effect of solid waste disposal from paper mill on the productivity of rice (oryza sativa I. Var mahsuri) plant.

Dutta, S. K.
Ecology, Environment and Conservation 11(3-4): 531-535. (2005)

NAL Call #: QH183.E238; ISSN: 0971765X [EECOF]

Descriptors: grain yield/ particle/ productivity/ solid waste/ crop performance/ productivity/ pulp and paper industry/ rice/ soil amendment/ waste disposal/ Asia/ assam/ Eurasia/ India/ South Asia/ oryza sativa

Abstract: The solid waste disposal system of Nagaon paper Mill, Jagiroad, Assam is one of the major problem in the Jagiroad area. An attempt was made to investigate the physical and chemical properties of solid waste and soil in order to evaluate their effectiveness on productivity on rice plant. For the purpose, solid waste were taken and its particulate size pH, organic matter, texture, porosity, water holding capacity, water retaining capacity, sodium absorption ratio (SAR), exchangeable sodium percentage (ESP), Total Alkalinity and water soluble anions and cations, carbonates, Bi-carbonates and chlorides, sodium, calcium, magnesium, potassium, sulphur, phosphorus and iron were analysed. Similarly, plant height, root characters, number of flower and fertilized flower and grain yield were estimated on rice plants. The plant growing on solid waste/soil mixture were compared with those growing on control soil. On the basis of physical and chemical properties of solid waste, grain produced by the plants growing in solid waste/soil mixture failed to produce the expected yield. It may be concluded that use of solid waste/

soil mixture for paddy cultivation could not be recommended. Hence, for the disposal of solid waste an alternative arrangement should be made, such as disposal of solid waste for landfilling operations in the non-cultivated lands and wetlands may be recommended. Copyright EnviroMedia.

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623. Effect of spring application of a paper mill soil conditioner on corn yield.

Curnoe, W. E.; Irving, D. C.; Dow, C. B.; Velema, G.; and Unc, A.

Agronomy Journal 98(3): 423-429. (May 2006-June 2006)
NAL Call #: 4 AM34P; ISSN: 0002-1962

Descriptors: Zea mays / corn/ grain yield/ soil conditioners/ pulp and paper sludge/ application timing/ spring / sandy soils/ nitrogen content/ soil fertility/ phosphorus/ potassium/ magnesium/ soil organic matter/ soil ph/ soil quality/ application rate/ ammonium nitrate/ mineral fertilizers/ plant nutrition/ nitrate nitrogen/ leaching/ waste utilization/ Ontario

Abstract: Use of paper mill residuals as soil amendment on farmland is believed to have a beneficial impact on crop yields and soil quality. The objective of our study was to evaluate the effect of spring applying Domtar Soil Conditioner (SC) (pulp and paper mill waste water treatment residue) to a sandy soil in eastern Ontario, Canada. The effects of SC on corn (*Zea mays* L.) yields, N concentrations in plants, and post-harvest levels in soil of NO₃, P, K, Mg, organic matter (OM), and pH were investigated. The experimental design was a randomized complete block with five treatments, replicated four times. The treatments included two SC rates (15 and 25 Mg ha⁻¹ dry matter: SC15 and SC25), 150 kg ha⁻¹ NH₄NO₃-N (N150), a composite SC and mineral fertilizer treatment (15 Mg ha⁻¹ dry matter SC and 75 kg ha⁻¹ NH₄NO₃-N: SC15N75), and a control. The experiment was repeated annually from 1997 to 2001. Addition of SC the spring before planting increased grain yield by 2360 kg ha⁻¹ for SC15 and by 2908 kg ha⁻¹ for SC25 vs. the control. When N was also added (SC15N75), the average increase vs. the control was 3406 kg ha⁻¹. More total N was measured in the corn plants from the plots amended with SC than the control. The SC amendments temporarily increased soil OM but did not increase NO₃-N leaching risk. Annual spring application of SC improved corn yield but had little impact on soil nutrient levels, OM, and pH.

This citation is from AGRICOLA.

624. Effect of various substrates on the growth and quality of mushrooms.

Ponmurugan, P.; Sekhar, Y. N.; and Sreesakthi, T. R.
Pakistan Journal of Biological Sciences 10(1): 171-173. (2007)

NAL Call #: QH301 .P355; ISSN: 1028-8880

Descriptors: amino acids/ biomass production/ calcium/ cane molasses/ chemical composition/ crop quality/ dry matter accumulation/ edible fungi/ growth/ lipids/ magnesium/ nutritive value/ organic wastes/ paper mill sludge/ phosphorus/ potassium/ protein content/ rice/ rice straw/ sawdust/ straw/ substrates/ sugars/ Lentinaceae/ lipins/ nutritional value/ paddy/ Poriales/ quality for nutrition
Abstract: The effect of different biowastes such as rice straw, sorghum straw, sugarcane molasses, sawdust and

paper waste on the growth and biochemical constituents of oyster mushroom (*Pleurotus florida*) was studied.

Favourable conditions were created to attain the maximum yield of mushrooms. The results revealed that mushroom growth was best in rice straw followed by sugarcane molasses and least in wood sawdust and paper waste. The growth of mushrooms may be coincided with type of substrates used that leads to tremendous utilization of nutrients in the biowastes. The results further indicated that the biometric parameters such as fresh weight, dry weight and dry matter accumulation and biochemical constituents such as total sugars, protein, amino acids and lipids were also highest in mushrooms grown in rice straw followed by sugarcane molasses and least in wood sawdust and paper waste. The microelements such as phosphorous, potassium, calcium and magnesium were also highest in mushrooms grown in rice straw when compared to the other substrates.

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625. The effect of waste water on root growth and mitosis in onion (*Allium cepa*) root apical meristem.

Dane, F.; Ekici, N; and Aktas, Y. K.

Asian Journal of Plant Sciences 5(2): 331-334. (2006);
ISSN: 1682-3974

Descriptors: apical meristems/ genotoxicity/ growth/ mills/ mitosis/ onions/ paper mill sludge/ phytotoxicity/ root tips/ textile mills/ waste water

Abstract: In this study, the phytotoxic and genotoxic effects of waste waters and also mitotic index were investigated in onion (*Allium cepa*) root tip cells during germination. Samples of water from effluent channels of Olmuksa paper, paddy and textile thread mills were collected in Edirne-Turkey on March 2002. The mineral content of the effluent was monitored by flame AAS and pH values of samples were measured. Tap water was used as control. The mitotic frequency of the onion root tip meristematic cells increased in samples of water from effluent channels. On the basis of present findings it may be concluded that low concentrations of minerals in waters of effluent channels of textile thread, paddy and Olmuksa paper mills has some positive effects on the root growth and mitotic divisions in onion root tip cells.

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626. Effect on deinking paper sludge compost on nutrient uptake and yields of snap bean and potatoes grown in rotation.

Baziramakenga, R. and Simard, R. R.

Compost Science and Utilization 9(2): 115-126. (2001)
NAL Call #: TD796.5.C58 ; ISSN: 1065657X [CSUTE]

Descriptors: Canada/ composting/ concentration (parameters)/ crop rotation/ cultivar/ fertilizer application/ growing season/ nutrient uptake/ paper industry/ phaseolus vulgaris/ plant growth/ plant residue/ plant yield/ rural area/ soil/ solanum tuberosum/ waste disposal/ compost/ crop yield/ nutrient uptake/ pulp and paper industry/ vegetable

Abstract: The paper industry in Canada faces a challenge of economically sound and environmentally safe disposal of massive amounts of residues. A field study was conducted in 1996 and 1997 to evaluate the effects of application of a compost derived from a mixture of deinking paper residues

and poultry manure (DSPC) on P and K uptake, and yields of snap bean (*Phaseolus vulgaris* L. cv. Centralia), and potato (*Solanum tuberosum* L. cv. Gold Rush). The experiment was conducted on a Tilly silt loam (Gleyed Humo-Ferric Podzol) located in Sainte-Croix de Lotbiniere, Quebec, Canada. The DSPC was applied in the spring 1996 at 0, 14, 28 and 42 Mg ha⁻¹ on a dry matter basis, and supplemented or not with mineral fertilizer (MF) at 0, 60, 120 and 180 kg P₂O₅-K₂O ha⁻¹. In 1997, P fertilizer was applied in subplots at 0, 100, 200 and 300 kg P₂O₅ ha⁻¹. Snap bean yield increased significantly with DSPC and MF application. Apparent P and K recoveries from MF by snap bean decreased with DSPC or MF rate. In combination with DSPC, P and K recoveries from MF by snap bean were smaller at all rates than those with no DSPC. Based on nutrient uptake, P and K in DSPC were more available than in MF. Potato yield in the following year was not significantly influenced by the previous treatments nor by supplemental P fertilizer added in the second year. This experiment indicates that compost derived from a mixture of deinking papermill sludges and poultry manure is a potential source of P and K for crops and will increase crop yields in the application year.

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627. Effects of amendments of paper mill sludge and nutrients on soil surface CO₂ flux in northern hardwood forests.

Wang ChuanKuan; Feldkirchner, D. C.; Gower, S. T.; Ferris, J.; and Kruger, E. L.

Journal of Forestry Research 16(4): 265-269. (2005); ISSN: 1007-662X

Descriptors: application to land/ carbon dioxide/ fertilizers/ industrial wastes/ paper mill sludge/ soil amendments/ soil temperature/ soil water content/ land application/ United States of America

Abstract: Safe and economical disposal of paper mill sludge is a key consideration for forest products industry. A study was conducted to examine the effects of amendments of sludge and nutrients on soil surface CO₂ flux (R_s) in northern hardwood forests and to quantify the relationship among R_s, soil temperature, and moisture in these stands. The experiment was a randomized complete block design that included sludge-amended, fertilized, and control treatments in sugar maple (*Acer saccharum* Marsh) dominated hardwood forests in the Upper Peninsula of Michigan, USA. Results showed that R_s was positively correlated to soil temperature (R²=0.80, p<0.001), but was poorly correlated to soil moisture. Soil moisture positively affected the R_s only in the sludge-amended treatment. The R_s was significantly greater in the sludge-amended treatment than in the fertilized (p=0.033) and the control (p=0.048) treatments. The maximum R_s in the sludge-amended treatment was 8.8 micro mol CO₂.m⁻².s⁻¹, 91% and 126% greater than those in the fertilized (4.6 micro mol CO₂.-2.s-1) and control (3.9 micro mol CO₂.m-2.s-1) treatments, respectively. The R_s did not differ significantly between the fertilized and control treatments. The difference in R_s between sludge-amended and the other treatments decreased with time following treatment. Reproduced with permission from the CAB Abstracts database.

628. Effects of composted pulp and paper industry wastewater treatment residuals on soil properties and cereal yield.

Sippola, J.; Makela Kurto, R.; and Rantala, P. R.

Compost Science and Utilization 11(3): 228-237. (2003)

NAL Call #: TD796.5.C58 ; ISSN: 1065-657X

Descriptors: application rates/ barley/ bulk density/ calcium/ carbon nitrogen ratio/ clay soils/ composting/ composts/ crop yield/ fertilizers/ heavy metals/ mineralization/ nitrogen/ oats/ paper mill sludge/ phosphorus/ porosity/ potassium/ pulp mill effluent/ silty soils/ sludges/ soil chemical properties/ soil density/ soil physical properties/ soil types/ waste management/ waste utilization/ waste water/ waste water treatment/ chemical properties of soil/ kraft mill effluent/ physical properties of soil

Abstract: The aim of this study was to investigate effects of pulp and paper industry wastewater treatment sludge composts on soil and cereal crops. Five forest industry wastewater sludge composts were tested in a field study which was conducted in a silty clay soil in southern Finland with barley in 1998, with oats in 1999 and with barley in 2000. Two composts contained only pulp mill biosludge and bark in a ratio of 1:4 and 1:2, respectively. Two other composts were mixtures of biosludge and primary sludge with the addition of bark in a ratio of 1:2 and 3:4, respectively. These two wastewater sludges originated from a pulp mill and from a recycled paper mill. The fifth compost consisted of biosludge and primary sludge from a board mill. Two application rates of each compost were studied: the low rate was based on an annual P fertilization rate recommended for barley, 50-200 m³/ha; and the high rate was a double or triple the low rate depending on the mineral N concentration of the compost, 150-600 m³/ha. Based on the Finnish fertilizer recommendations, nutrient demands of the test plants were annually fulfilled by mineral fertilizers depending on the treatment. Total contents of N, P, K and Ca in composts were 8.8-17.5, 0.7-3.9, 1.5-6.5, and 4-25 g/kg dry matter, respectively. Especially at high doses, composts had beneficial effects on soil bulk density, porosity, C and N contents and C:N ratio. Despite the high total N rates applied with the composts, the mineralization following crop harvest did not significantly increase soil nitrate late autumn or following spring as compared to the soils that received mineral fertilization. There was no significant difference in the grain yields between plots that received mineral fertilization and compost treatments supplemented with mineral fertilizers. However, there was a decreased fertilization effect of some composts on straw yields during the first experimental year, indicating immobilization of mineral N. Heavy metals added in soil with the composts did not significantly increase their concentrations in the grain crops. All the composts had relatively low nutrient contents and low fertilizing value, but beneficial effects on soil properties and were regarded as soil conditioners. Soil improving and fertilizing effects of the composts varied annually depending on the weather conditions during the growing season. Heavy metal concentrations of the composts studied were far below the limit values set for the soil conditioners in the Finnish government regulations.

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629. Effects of de-inking paper sludges on soil properties and crop yields.

Simard, R. R.; Baziramakenga, R.; Yelle, S.; and Coulombe, J.

Canadian Journal of Soil Science 78(4): 689-697. (1998)
NAL Call #: 56.8 C162 ; ISSN: 0008-4271

Descriptors: barley/ nitrogen fertilizers/ nutrient availability/ paper mill sludge/ phosphorus/

potassium/ pulp and paper industry/ silt loam soils/ soil amendments/ soil chemistry/ soil types/ soil water/ strawberries/ yields/ paper industry/ soil moisture

Abstract: The effects of the use of raw de-inking paper sludges (RDS) as a soil amendment on soil chemical properties, barley (*Hordeum vulgare*) growth, nutrient uptake and yields, and their residual effect on a subsequent strawberry (*Fragaria x ananassa*) crop were investigated on a Tilly silt loam (gleyed humo-ferric Podzol) from 1994 to 1996 in Ste-Croix (46 degrees 39' N, 72 degrees 06' W), Quebec, Canada. Four rates of RDS (0, 15, 30 and 45 t/ha) on a wet-weight basis were combined with four rates of supplemental N-mineral fertilizer (0, 45, 90 and 135 kg/ha) as NH_4NO_3 . The soluble inorganic N content of soil sampled 30 d after treatment application was significantly lower in plots treated with 45 t RDS/ha at all N rates. However, soluble inorganic N concentrations increased significantly with RDS rate to 20-cm depth in June 1995. The RDS application increased soil water content and Mehlich-3-extractable P, K, and Ca in the first year. Barley yields were reduced by 50% when 45 t RDS/ha was applied without supplemental N-mineral fertilizer. The amount of N-mineral fertilizer needed to overcome N immobilization resulting from RDS increased with RDS rates. Strawberry yields were not significantly affected by residual RDS or N-mineral fertilizer. Changes in plant tissue metal contents were not significant. The results indicate that RDS has a positive short-term effect on soil water, P and K availability but reduces plant-available soil N in the growing season after spring application. The RDS may be used effectively as soil amendment if the crop receives adequate supplemental N-mineral fertilizer.

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630. Effects of diverse amounts of deinking residues on the stability of pore structure of three types of soils in Quebec, Canada.

Nemati, Mohammad-Reza

Canada: Universite Laval, Sainte-Foy, QC, Canada (CAN), 1999.

Notes: Original title: Effets de diverses doses de residus de desencrage sur la stabilite du reseau poral de trois types de sol du Quebec (Canada). Language of article: French.

Descriptors: Canada/ Eastern Canada/ hydraulic conductivity/ loam/ models/ Quebec/ soils/ stability/ soils © American Geological Institute

631. Effects of five non-agricultural organic wastes on soil composition, and on the yield and nitrogen recovery of Italian ryegrass.

Douglas, J. T.; Aitken, M. N.; and Smith, C. A.

Soil Use and Management 19(2): 135-138. (2003)

NAL Call #: S590.S68; ISSN: 0266-0032

Descriptors: application to land/ clay loam soils/ crop yield/ dairy wastes/ distillery effluent/ dry matter accumulation/

organic wastes/ paper mill sludge/ recovery/ soil composition/ soil types/ Britain/ land application/ United Kingdom

Abstract: We studied the effects of five diverse non-agricultural organic wastes on soil composition, grass yield and grass nitrogen use in a 3-year field experiment. The applied wastes were distillery pot ale, dairy salt whey, abattoir blood and gut contents, composted green waste (two annual applications each), and paper-mill sludge (one annual application). With the exception of N immobilization in the paper-mill sludge treatment, the wastes had no unfavourable effects on the soil. In the 2-year treatments, grass dry matter yields from the abattoir and distillery wastes (26.3 t ha⁻¹) were larger than those from a NH_4NO_3 fertilizer treatment (24.3 t ha⁻¹) and from the dairy waste (20.4 t ha⁻¹) and composted waste (22.8 t ha⁻¹). Yield and N recovery were impaired markedly after the single application of paper-mill sludge, both in the year of application and in the following year. The results demonstrated clear differences in the ability of the applied wastes to provide crop-available N. We conclude that in order to improve prediction of both the benefits and risks from waste recycling to land, more information should be gathered on soil/waste/crop interactions. Reproduced with permission from the CAB Abstracts database.

632. Effects of fresh paper mill sludges and their composts on soil macro-aggregates.

Bipfubusa, M; N'Dayegamiye, A; and Antoun, H

Canadian Journal of Soil Science 85(1): 47-55. (2005)

NAL Call #: 56.8 C162 ; ISSN: 0008-4271.

Notes: Original title: Effets de boues mixtes de papeteries fraiches et compostees sur l'agregation du sol, l'inclusion et la mineralisation du C dans les macro-agregats stables a l'eau.

Descriptors: aggregates/ application/ application rates/ carbon/ chemical composition/ composts/ diameter/ Humic Gleysols/ maize/ maize silage/ mineralization/ nitrogen fertilizers/ paper mill sludge/ silage/ silt loam soils/ soil amendments/ soil physical properties/ soil structure/ soil types/ corn/ physical properties of soil

Abstract: Soil aggregation is influenced by physical and chemical properties of organic materials applied to the soil. The objective of this study was to evaluate the effects of fresh paper mill sludges and their composts, and their application frequency on soil aggregation, mean weight diameter of aggregates (MWD) and on the C content and C mineralization from water-stable aggregates. The experiment was established on a Le Bras silt loam (Humic Gleysol) under silage corn (*Zea mays* L.) production, and was designed as a split-plot experiment with six treatments in the main plots that were applied at two frequencies (annual and biennial) in the sub-plots. Paper mill sludges and their composts were applied at 40 t ha⁻¹ on a wet basis, alone or completed with 120 kg N ha⁻¹. Those treatments were compared to mineral N fertilization (160 kg ha⁻¹) recommended for silage corn, and the control. Soil aggregation was assessed by wet soil sieving on a nest of 5-mm, 2-mm, 1-mm and 0.25-mm sieves. Soil C contents and mineralization were determined on whole soil and on >5 mm, 2-5 mm and 0.25-2 mm aggregate classes. Fresh and composted paper mill sludges significantly ($P < 0.05$) increased the proportion of water-stable aggregates >5

mm, the MWD of aggregates and the C content of aggregate fractions, compared to the control and the mineral N fertilizer treatment. However, the abundance of >5 mm aggregates and the MWD of aggregates were significantly decreased when fresh paper mill sludges were combined with mineral N fertilizer, suggesting a fast mineralization of binding agents. In contrast, N fertilizer application has not reduced soil macro-aggregates >5 mm and the MWD of aggregates in paper mill compost treatments, probably due to resilience to degradation of humic substances brought by the composts. On average, carbon mineralization was highest in all aggregates in soils with paper mill sludges, than for their composts, which suggests that paper mill sludge C was more labile than compost C. Therefore, more frequent fresh paper mill sludge applications would be necessary for a sustainable effect on soil aggregation.

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633. Effects of iron precipitation and organic amendments on porosity and penetrability in sulphide mine tailings.

Forsberg, Lovisa Stjernman and Ledin, Stig
Water, Air and Soil Pollution 142(1-4): 395-408. (2003)

NAL Call #: TD172 .W36; ISSN: 0049-6979

Descriptors: pollution assessment control and management/ soil science/ waste management: sanitation/ plantae: plants/ laboratory experiment: laboratory techniques/ boliden mineral Ab/ hard pan formation/ mechanical resistance/ organic amendments: paper mill sludge, peat moss, sewage sludge/ oxidation processes: soil amendment magnification/ plant available water/ plant habitat requirements/ pore size distribution/ soil water potential/ sulfide mine tailings: fertilized/ sludge amended/ iron precipitation effects/ organic amendment effects/ oxidized/ penetrability/ porosity/ unaltered

Abstract: This paper evaluates the effects of organic amendments and iron precipitation on pore size distribution and mechanical resistance in sulphide mine tailings, as related to plant habitat requirements. Unaltered tailings, oxidised tailings collected from untreated, fertilized and sludge-amended plots in the field, and mixtures of unaltered tailings and organic amendments prepared in the laboratory, were analysed for pore size distribution. The organic amendments (sewage sludge, peat moss and paper mill sludge) were each applied at the rates of 0, 16 and 33% by volume. A difference in pore-size distribution between untreated and treated samples was shown in both field and laboratory samples. Both inorganic and organic amendments caused a decrease in pores holding water at soil water potentials -10 to -60 kPa, but increased the pores holding water at tensions below -60 kPa. This resulted in a decreased or unchanged content of plant available water (W_a) in all laboratory samples and in the fertilized field samples. Penetration studies in the field showed that additions of fertilizer, without any organic matter, had resulted in hard pans in the oxidised tailings that significantly increased the mechanical resistance in the surface horizon. Thus, this study indicates that the physical influence of the oxidation processes taking place in sulphide mine tailings can be magnified by additions of soil amendments. The aggregation of iron oxides and

negatively charged particles such as organic substances or phosphate anions may cement the tailings, which can result in impeded root growth.

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634. Effects of located application of papermill residues on crop yields and soil quality.

Cambouris, A. N.; Nolin, M. C.; and Simard, R. R.

In: Proceedings of the 5th International Conference on Precision Agriculture. Bloomington, Minnesota, USA.; pp. 1-16; 2001.

Descriptors: bulk density/ crop yield/ nutrients/ paper mill sludge/ porosity/ potatoes/ precision agriculture/ sandy soils/ soil density/ soil organic matter/ soil types/ sustainability/ topsoil/ water holding capacity/ wheat/ organic matter in soil/ precision farming/ site specific crop management/ soil quality

Abstract: Improving yield crops and maintaining soil quality are major concerns of sustainable agriculture. Sandy soils in intensive potato (*Solanum tuberosum*) production are very sensitive to soil organic matter (SOM) depletion. Low SOM contents in sandy soils often mean reduced water storage capacity, nutrient holding capacity, yield potential and high risks of water and wind erosion. A 24-ha field in Quebec City, Canada, was chosen for a precision agriculture study as the 1996 yield map showed a high spatial variability. Soyabean yields were spatially related to SOM content suggesting that SOM is linked with yield limiting factors. The objective of this study was to evaluate the efficiency of located application of five paper mill residues (PR) as a SOM source on tuber yield and soil quality. The PR were applied in May 1997 before planting at rates according to the initial SOM content (estimated by kriging): $\geq 5\%$ (no PR applied), 4.0-4.9% (low rate), 3.0-3.9% (medium rate) and $< 3\%$ (high rate). In 1997, PR application increased potato yields in areas of $< 3\%$ SOM. In 1998, PR application had a positive residual effect on spring wheat (*Triticum aestivum*) yield. Improving trends were also observed one year after PR application on the topsoil bulk density, total porosity and water storage capacity but this was only significant for the high C/N PR applied at a high rate ($< 3\%$ SOM). Precision application of PR is an efficient way to improve crop yields and the quality of these sandy soils.

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635. Effects of organic mulches on soil microfauna in the root zone of apple: Implications for nutrient fluxes and functional diversity of the soil food web.

Forge, T. A.; Hogue, E.; Neilsen, G.; and Neilsen, D.

Applied Soil Ecology 22(1): 39-54. (2003)

NAL Call #: QH541.5.S6 A67; ISSN: 0929-1393

Descriptors: apples/ composts/ diversity/ food webs/ hay/ lucerne/ lucerne hay/ microbial flora/ mineralization/ mulches/ nitrogen/ paper mill sludge/ phosphorus/ roots/ sewage sludge/ soil fauna/ alfalfa/ alfalfa hay/ Diplogasteridae/ fluxes/ microbial biomass/ microflora/ mulching materials

Abstract: A variety of organic materials (e.g. composts, paper recycling wastes, hay) can be used as in-row mulches in perennial horticultural cropping systems such as high density apple orchards. As organic materials with

variable properties, such mulches can be expected to have variable effects on structure of the soil food web and mineralization of N and P in the root zone. The overall objectives of this study were to: (1) assess the effects of a selection of organic mulches on the abundance of protozoa and nematode trophic groups; (2) use the model of Hunt et al. [See *Biol. Fertil. Soils* (1987) 3:393] to assess the implications of changes in microfaunal abundance for microbial turnover and N mineralization; and (3) determine effects of the mulches on nematode indicators of increased microbial production/turnover and functional diversity of the soil food web. Organic mulch treatments commenced in 1994 and included shredded office paper, municipal sewage sludge, shredded paper applied over municipal sewage sludge, shredded paper applied over municipal compost, lucerne hay, and black polyethylene fabric. The control was conventional tree-row weed management with glyphosate. Sewage sludge and municipal compost treatments were re-applied in 1997. Protozoan abundance was determined in 1998, 1999 and 2000. Nematode community structure was assessed in 1998, 1999, and twice in 2000. Nematode community parameters evaluated included: abundance of bacterivorous, fungivorous, omnivorous and predacious nematodes; abundance of the root-lesion nematode, *Pratylenchus penetrans*; absolute and relative abundances of enrichment opportunist nematodes

Rhabditidae+Diplogasteridae+Panagrolaimidae); Simpson's diversity; evenness; and the indices of nematode community enrichment (EI) and structure (SI) described by Ferris et al. [See *Appl. Soil Ecol.* (2001) 18:13]. Measurements of the abundance of enrichment opportunists and the EI were evaluated as indicators of enhanced nutrient fluxes. Diversity and the SI were evaluated as indicators of changes in functional diversity of the soil food web. The abundance of protozoa and bacterivorous nematodes, and estimated fluxes of N and P through the microfauna, were greater under all combinations of sewage sludge or municipal compost and shredded paper than under the control and plastic mulch. The abundance of enrichment opportunist nematodes and the EI were also consistently greater under combinations of sewage sludge or municipal compost and shredded paper. The abundance of enrichment opportunists and EI were both also correlated with leaf P, providing additional evidence to support the use of these parameters as indicators of enhanced turnover of microbial biomass and nutrients. The SI was greatest under shredded paper and shredded paper applied over municipal compost, and least under municipal sewage sludge and lucerne hay. Population densities of *P. penetrans* were reduced under shredded paper mulch relative to the control and sewage sludge alone.

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636. Effects of paper mill sludge application on early growth of *Acer palmatum* thub and soil physicochemical properties of forest nursery.

Park, H. and Lee, D. K.

Journal of Korean Society of Soil Science and Fertilizer 3(1): 39-45. (Mar. 1998); ISSN: 0367-6315.

Notes: 1 illu.; 4 tables; 17 ref. Summaries (En, Ko). Citation notes: KR (Korea-Republic-of).

Descriptors: paper mill sludge/ application/ early growth/ *Acer palmatum*/ soils/ forest nursery
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637. Effects of paper mill sludge on potassium, sodium, calcium, and magnesium concentrations in different soybean cultivars.

Yan XiangKui; Chang, K. W.; and Xu, H. L.

Pedosphere 15(1): 84-94. (2005)

NAL Call #: S590 .P43 ; ISSN: 1002-0160

Descriptors: calcium/ chemical composition/ cultivars/ magnesium/ paper mill sludge/ plant composition/ potassium/ sodium/ soil amendments/ soybeans/ chemical constituents of plants/ cultivated varieties/ South Korea/ soybeans

Abstract: A field experiment was conducted on a sandy loam soil at an Experimental Farm in Taejon, South Korea, to determine the effects of paper mill sludge compost application rates on K, Na, Ca and Mg concentrations of soybean (*Glycine max* (L.) Merr.) aboveground tissues and the genotypic effects on the concentrations of these elements. Sludge compost treatments of 0, 75, and 150 t ha⁻¹ were applied to 30 diverse soybean cultivars. Concentrations of K, Na, Ca, and Mg in aboveground tissues harvested 69 days after planting (DAP) varied with the genotype and the application rate of paper-mill sludge compost, with the sludge compost application rate exerting stronger influence on these concentrations than the genotype. The magnitude of variation caused by both genotype and sludge compost application was in the order of Mg > K > Ca > Na. Significantly positive correlations were observed between K and Na (P<0.01), Na and Ca (P<0.05), and Ca and Mg (P<0.01). Also, the lower the sludge compost application rate, the larger the variation in the concentrations of K, Na, and Ca. From this several cultivars were identified for use as an accumulator for one or more of these elements.

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638. Effects of pulp fibre on soil physical properties and soil erosion under simulated rainfall.

Chow, T. L.; Rees, H. W.; Fahmy, S. H.; and Monteith, J. O.

Canadian Journal of Soil Science 83(1): 109-119. (2003)

NAL Call #: 56.8 C162 ; ISSN: 0008-4271

Descriptors: application rates/ bulk density/ composting/ composts/ erosion/ erosion control/ heavy metals/ horizons/ loam soils/ macropores/ organic matter/ paper mill sludge/ runoff/ saturated hydraulic conductivity/ sediment yield/ soil amendments/ soil conservation/ soil density/ soil fertility/ soil physical properties/ soil types/ soil water content/ soil water movement/ soil water retention/ waste management/ waste utilization/ physical properties of soil

Abstract: Pulp fibre, a primary type of sludge of pulp and paper mills containing approximately 40% organic C, is usually disposed of in landfills causing a potential environmental problem. This material may be used as a soil amendment to restore the productivity of organic-matter-depleted potato-producing soils in Atlantic Canada. The effect of incorporating this material at rates equivalent to 0.5, 1.0, 2.0, and 4.0% organic matter in the plow layer of a gravelly loam soil on selected soil physical properties and soil erosion was evaluated. The objectives were to determine the effect of pulp fibre additions on selected soil

properties, which are pertinent to water retention and movement and to evaluate its effectiveness in reducing runoff and soil loss, major contributing processes to soil degradation. Chemical analysis of pulp fibre revealed that all heavy metal concentrations were well below allowable concentrations for Category A compost. One year after incorporation, bulk density of the Ap horizon had decreased with increasing rates of organic matter addition. On the other hand, the saturated hydraulic conductivity and specific moisture content increased with increasing rates of treatments. Results on water-stable aggregates revealed that the organic matter in the pulp fibre combined smaller aggregates to form larger aggregates, resulting in a larger proportion of macropores as compared to micropores. In the 4% organic matter treatment, a 27% increase was found in the 1.0 to 5.0 mm-diameter aggregates whereas a 23% reduction was found in aggregates smaller than 1.0 mm diameter. In spite of the higher specific moisture content of the organic-matter-treated soils, soil moisture content measured immediately prior to the erosion test indicated that field soil moisture contents were lower than those of the control. Time of runoff initiation, rates of runoff and soil loss were greatly improved with the amendments. The beneficial effects of the 4% organic matter treatment include 2.1 times delay in runoff initiation, and 23 and 71% reduction in runoff and soil loss, respectively. Although the beneficial effects in soil and water conservation are apparent, a minor drawback appears to be lower field soil moisture content. Large-scale implementation of the addition of this material in potato fields should proceed only with caution.

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639. Effects of soil on trace metal leachability from papermill ashes and sludge.

Xiao, C.; Ma, L. Q.; and Sarigumba, T.
Journal of Environmental Quality 28(1): 321-333. (1999)
 NAL Call #: QH540.J6; ISSN: 0047-2425
Descriptors: ash/ cadmium/ chromium/ copper/ leachates/ leaching/ lead/ metals/ paper mill sludge/ selenium/ soil/ soil amendments/ trace elements/ wastes/ zinc/ microelements
Abstract: Trace metal leachability from paper mill ashes (Ash 1 and Ash 2) and paper mill sludge (Sludge), and the effects of a soil on their leachability were determined by leaching the three paper mill residues packed on top of a soil in a column. The leachates were analysed for pH, electrical conductivity (EC), dissolved organic carbon (DOC), and concentrations of six metals (Cd, Cr, Cu, Pb, Se, and Zn). Ash 1 behaved significantly differently from Ash 2 during the leaching experiment, primarily due to its high pH and Na contents. Application of paper mill residues significantly increased the pH, EC, and DOC concentrations in leachates, with Ash 1 having significantly greater impacts than Ash 2 and sludge. Soil columns under alkaline leaching of Ash 1 appeared bleached due to the dissolution of solid-phase organic matter. Significant amounts of Zn were leached from all paper mill residues, whereas significant amounts of Cr, Se, and Cu were leached only in the Ash 1 treatments. The presence of a soil (especially a Bh horizon) generally enhanced metal leachability in the Ash 1 treatments due to the extremely high pH of Ash 1, whereas it decreased metal leachability in the Ash 2 and sludge treatments. Thus, organic matter enhances metal

sorption when present as a solid phase, but it increases metal leachability when present in dissolved form under alkaline conditions.

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640. Effects of soil on tree metal leachability from papermill ashes and sludge.

Xiao, C.; Ma, L. Q.; and Sarigumba, T.
Journal of Environmental Quality 28(1): 321-333. (Jan. 1999-Feb. 1999)
 NAL Call #: QH540.J6; ISSN: 0047-2425 [JEVQAA]
Descriptors: leaching / land application/ soil chemistry/ forest soils/ paper mill sludge
Abstract: Understanding trace metal leachability is important for successful land application of papermill residues. Trace metal leachability from papermill ashes (Ash 1 and Ash 2) and papermill sludge (Sludge), and the effects of a soil on their leachability were determined by leaching the three papermill residues packed on top of a soil in a column. The leachates were analyzed for pH, electrical conductivity (EC), dissolved organic carbon (DOC), and concentrations of six metals (Cd, Cr, Cu, Pb, Se, and Zn). Ash 1 behaved significantly differently from Ash 2 during the leaching experiment, primarily due to its high pH and Na contents. Application of papermill residues significantly increased the pH, EC, and DOC concentrations in leachates, with Ash 1 having significantly greater impacts than Ash 2 and sludge. Soil columns under alkaline leaching of Ash 1 appeared bleached due to the dissolution of solid-phase organic matter. Significant amounts of Zn were leached from all papermill residues, whereas significant amounts of Cr, Se, and Cu were leached only in the Ash 1 treatments. The presence of a soil (especially a Bh horizon) generally enhanced metal leachability in the Ash 1 treatments due to the extremely high pH of Ash 1, whereas it decreased metal leachability in the Ash 2 and sludge treatments. Thus, organic matter enhances metal sorption when present as a solid phase, but it increases metal leachability when present in dissolved form under alkaline conditions.
 This citation is from AGRICOLA.

641. Envirobed: An environmental outlet for papermill sludge.

Paper Technology 47(1): 11-12. (2006); ISSN: 0306252X [PATEE]
Descriptors: biodegradation/ cost effectiveness/ paper and pulp mills/ research and development management/ bedding materials/ envirosystems (co)/ farmers/ sewage sludge/ biodegradation/ cost effectiveness/ paper mills/ pulp mills/ sludge
Abstract: EnviroSystems of Lancashire, UK, has developed Envirobed from a two year research and development project. Envirobed is used as a bedding material for animals throughout the UK. The sludge is derived from Bridgewater and Shotton and processed at the Ceshire plant of EnviroSystems. Then it is treated in two stages and the process produces a soft adsorbent product which biodegrades easily and can be spread on land after use. It provides farmers with cost-effective alternative to traditional bedding.
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642. Environmental effects of deinking sludge application on soil and soil water quality.

Trepanier, L.; Gallichand, J.; Caron, J.; and Theriault, G. *Transactions of the ASAE* 41(5): 1279-1287. (Sept. 1998-Oct. 1998)

NAL Call #: 290.9 Am32T; ISSN: 0001-2351 [TAAEAJ]

Descriptors: land application/ soil types/ chemical analysis/ monitoring/ soil pollution/ waste utilization/ Solanum tuberosum/ Hordeum vulgare / crop yield/ application rate/ sludges

Abstract: The pulp and paper industry produces deinking sludge, a waste by-product rich in organic matter and potentially beneficial to agricultural soils. Field experiments were performed with deinking sludge and a mix of deinking and secondary (combined) sludge to measure the environmental impact associated with landspreading. Treatments consisted of three application rates of deinking (6, 12, and 18 dry t/ha) or combined sludge (8, 16, and 24 dry t/ha) associated with three rates of supplementary mineral nitrogen fertilizer, and a control plot. Chemical analyses of deinking and combined sludge indicated that no organic and inorganic contaminants were present at problematic levels, except for copper (191 microgram/g). Soil monitoring of the nutrients and heavy metals in experimental plots showed no significant difference ($p = 0.05$) between sludge treatments and the control after two years of sludge application. Monitoring of nitrate in the soil water indicated a linear relationship (p less than or equal to 0.08) with the additional nitrogen level. High sludge and low nitrogen application rates were associated with reduced nitrate concentration in the soil water. Detrimental environmental effects were not observed with deinking and combined sludge. Compared to the control, potato yield tended to decrease with deinking and combined sludge applications while barley yield increased with combined sludge applications.

This citation is from AGRICOLA.

643. Environmental risk assessment of heavy metal extractability in a biosludge from the biological wastewater treatment plant of a pulp and paper mill.

Pöykiö, R.; Nurmesniemi, H.; and Keiski, R. L.

Environmental Monitoring and Assessment 128(1-3): 153-164. (2007)

NAL Call #: TD194 .E5 ; ISSN: 01676369 [EMASD].

Notes: doi: 10.1007/s10661-006-9301-y.

Descriptors: extraction/ heavy metals/ paper mill/ pulp mill/ sequential extraction/ sludge/ biological sewage treatment/ environmental impact assessments/ environmental protection/ extraction/ heavy metals/ risk assessment/ sewage sludge/ biological wastewater treatment plant/ biosludge/ heavy metal extractability/ sequential extraction/ wastewater treatment/ acetic acid/ ammonium acetate/ arsenic/ barium/ cadmium/ calcium/ chromium/ cobalt/ copper/ heavy metal/ hydrogen peroxide/ hydroxylamine/ iron/ lead/ magnesium/ manganese/ nickel/ nitrogen/ phosphorus/ potassium/ sodium/ sulfur/ vanadium/ zinc/ environmental protection/ european union/ heavy metal/ pulp and paper industry/ risk assessment/ sludge/ waste treatment/ wastewater/ agriculture/ alkalinity/ concentration (parameters)/ controlled study/ dry weight/ electric conductivity/ environmental health/ environmental protection/ european union/ finland/ metal extraction/ oxidation/ paper industry/ ph measurement/ pulp mill/ risk

assessment/ sludge treatment/ soil quality/ solubility/ waste water treatment plant/ industrial waste/ metals, heavy/ risk assessment/ sewage/ textile industry/ water pollutants, chemical/ eurasia/ europe/ finland/ northern europe/ scandinavia

Abstract: A five-stage sequential extraction procedure was used to fractionate heavy metals (Cd, Cu, Pb, Cr, Zn, Fe, Mn, Ni, Co, As, V and Ba) in a biosludge from the biological wastewater treatment plant of Stora Enso Oyj Veitsiluoto Mills at Kemi, Northern Finland, into the following fractions: (1) water-soluble fraction, (2) exchangeable fraction, (3) easily reduced fraction, (4) oxidizable fraction, and (5) residual fraction. The biosludge investigated in this study is a combination of sludge from the primary and secondary clarifiers at the biological wastewater treatment plant. Extraction stages (2)-(4) follow the protocol proposed by the Measurements and Testing Program (formerly BCR Programme) of the European Commission, which is based on acetic acid extraction (stage 2), hydroxylamine hydrochloride extraction (stage 3), and hydrogen peroxide digestion following the ammonium acetate extraction (stage 4). The residual fraction (stage 5) was based on digestion of the residue from stage 4 in a mixture of HF + HNO₃ + HCl. Although metals were extractable in all fractions, the highest concentrations of most of the metals occurred in the residual fraction. From the environmental point of view, it was notable that the total heavy metal concentrations in the biosludge did not exceed the maximal allowable heavy metal concentrations for sewage sludge used in agriculture, set on the basis of environmental protection of soil by European Union Directive 86/278/EEC, and by the Finnish legislation. The Ca (98.6 g kg⁻¹; dry weight) and Mg (2.2 g kg⁻¹; dry weight) concentrations in the biosludge were 62 and 11 times higher than the typical values of 1.6 and of 0.2 g kg⁻¹ (dry weight), respectively, in arable land in Central Finland. The biosludge had a slightly alkaline pH (~8.30), a high loss-on-ignition value (~78%) and a liming effect of 10.3% expressed as Ca equivalents (dry weight). This indicates its potential as a soil conditioner and improvement agent, as well as a pH buffer. © Springer Science+Business Media B.V. 2006. © 2009 Elsevier B.V. All rights reserved.

644. Evaluation of paper sludge as organic fertilizer for the growth of ryegrass on a Belgian clay soil.

Demeyer, A. and Verloo, M.

Agrochimica 43(5/6): 243-250. (1999)

NAL Call #: 385 AG84; ISSN: 0002-1857

Descriptors: amendments/ application rates/ characteristics/ clay soils/ degradation/ extracts/ immobilization/ microbial degradation/ nitrate/ nitrogen/ nutrient content/ paper mill sludge/ plant composition/ responses/ sludges/ soil/ yields/ chemical constituents of plants

Abstract: A pot experiment examined the effect of application of increasing doses of primary paper sludge to a Belgian clay soil on the yield and nutrient content of ryegrass (*Lolium perenne*). Results showed that high amounts of N were immobilized from the microbial degradation of sludge inducing a yield decrease. Nitrate accumulation in the plant and NO₃ concentration in the soil extract decreased with increasing doses of sludge. Reproduced with permission from the CAB Abstracts database.

645. Evaluation of the soil organic matter dynamics model MOTOR, for predicting N immobilization/mineralization following field incorporation of paper mill sludge in a horticultural soil.

Vinten, A. J. A.; Martin Olmedo, P.; Sattar, S.; Kuikman, P. J.; and Whitmore, A. P.

In: Sustainable Management of Soil Organic Matter/ Rees, R. M.; Ball, B. C.; Campbell, C. D.; and Watson, C. A. Wallingford (United Kingdom): CABI, 2001; pp. 126-134.

Descriptors: soil organic matter/ N-immobilization/ N-mineralization/ paper mill sludge/ horticultural soils

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646. Evaluation of traditional windrow-composting and vermicomposting for the stabilization of waste paper sludge (WPS).

Short, J. C. P.; Frederickson, J.; and Morris, R. M.

Pedobiologia 43(6): 735-743. (1999)

NAL Call #: 56.8 P343 ; ISSN: 0031-4056

Descriptors: biomass/ capacity/ coir/ comparisons/ composting/ cultivation/ evaluation/ mortality/ nitrate/ nitrogen/ nutrients/ nutritive value/ paper mill sludge/ properties/ radishes/ sludges/ stabilization/ stabilizing/ vermicomposting/ waste paper/ wastes/ Britain/ Capparales/ coconut fibre/ death rate/ *Dendrobaena veneta*/ nutritional value/ plant growth/ quality for nutrition/ United Kingdom

Abstract: Trials evaluating the processing of a waste paper sludge (WPS) using a traditional windrow-composting system, and a modular vermicomposting unit (VCU) system are described. The VCU system utilized the earthworm *Dendrobaena veneta* at near carrying capacity. Both composting processes produced good levels of stabilization in WPS after 8 weeks. Windrow-composting achieved a 70.4% reduction in volatile solids, significantly more than the VCU system, which achieved a 52.7% reduction ($P < 0.01$). This was reflected in total-fibre contents of 37.2% for windrow-composted WPS, significantly lower than 43.8% observed for VCU-composted WPS ($P < 0.05$). A total nitrogen loss of 41.3% in the VCU-composted WPS was significantly lower than the 70% loss observed for windrow-composted WPS ($P < 0.05$). VCU-composted WPS resulted in a product much higher in water-soluble (available) nutrients, especially nitrate ($P < 0.001$). A mean increase in earthworm biomass of 36.6%, with a mean mortality of 22.3%, occurred in the VCU system, indicating the high nutritional value of WPS for *D. veneta* cultivation. Radish plant growth trials using the final, matured, windrow-composted WPS showed significantly higher levels of plant growth than for VCU-composted WPS ($P < 0.05$), although plant growth increased significantly when VCU-composted WPS was diluted with coir ($P < 0.01$). Although both composting systems proved technically suitable for processing WPS, they are clearly different processes. These differences are reflected in the unique properties of composted WPS products, the implications of which require further investigation.

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647. Evidence of sequential decay in recycled paper sludge and pig manure mixtures.

Hobbs, P. J.; Johnson, R.; and Chadwick, D.

Animal, agricultural and food processing wastes Proceedings of the Eighth International Symposium, Des Moines, Iowa, USA, 9-11 October, 2000. 2000; 321-328(2000)

Descriptors: animal manures/ animal wastes/ conferences/ decay/ paper mill sludge/ pig manure/ pollution control/ pulps/ storage/ storage decay/ storage life/ deterioration in storage/ livestock wastes

Abstract: Recycled paper sludge was added to fresh pig slurry to monitor biochemical changes and to assess this approach as means of reducing the potential of pig slurry to pollute while in storage. Complex decay patterns emerged, some of which occurred at set times and independent of the ratio of the mixtures used, although higher storage temperature gave larger concentrations of decay products. Concentrations of acetic and propanoic acid peaked simultaneously through the study and products of proteolysis which were the branched chain VFAs, phenols and indoles peaked later, but less at lower storage temperatures. After maximum concentrations of VFAs at about 10 and 70 to 100 days, increasing amounts of ammoniacal N were observed with a subsequent increase of pH. Plant material appeared to be digested before proteolysis occurred, with the latter being temperature dependent. Recycled paper sludge reduced the soluble phosphate concentration and ammonia emissions from pig slurry. Explanations of sequences of decay and the time of sampling and volume of the experimental vessel in relationship to microbial communities are proposed. Reproduced with permission from the CAB Abstracts database.

648. Examination of environmental quality of raw and composting de-inking paper sludge.

Beauchamp, C. J.; Charest, M. H.; and Gosselin, A.

Chemosphere 46(6): 887-895. (2002)

NAL Call #: TD172 .C54; ISSN: 0045-6535

Descriptors: aromatic hydrocarbons/ arsenic/ boron/ cadmium/ chemical composition/ chromium/ cobalt/ composting/ composts/ dioxins/ fatty acids/ furans/ halogenated hydrocarbons/ lead/ manganese/ mercury/ molybdenum/ naphthalene/ nickel/ nitrogen/ paper mill sludge/ phosphorus/ polluted soils/ polychlorinated biphenyls/ polycyclic hydrocarbons/ potassium/ resin acids/ selenium/ soil amendments/ soil pollution/ soil types/ waste paper/ zinc/ Mn/ Mo/ PCBs/ polycyclic aromatic hydrocarbons/ soil quality

Abstract: Paper sludges were traditionally landfilled or burned. Over the years, the use of paper sludges on soils has increased, as well as the concerns about their environmental effects. Therefore, the chemical characterization of paper sludges and their young (immature) compost needed to be investigated, and over 150 inorganic and organic chemicals were analysed in de-inking paper sludge (DPS). In general, nitrogen, phosphorus and potassium contents were low but variable in raw DPS and its young compost. The contents of arsenic, boron, cadmium, cobalt, chromium, manganese,

mercury, molybdenum, nickel, lead, selenium, and zinc were also low and showed low variability. However, the copper contents were above the Canadian compost regulation for unrestricted use and required a follow-up. The fatty- and resin acids, and polycyclic aromatic hydrocarbons were the organic chemicals measured at the highest concentrations. For resinic acids, care should be taken to avoid that leachates reach aquatic life. For polycyclic aromatic hydrocarbons, naphthalene should be followed until soil content reaches 0.1 micro g g⁻¹, the maximum allowed for soil use for agricultural purposes according to Canadian Environmental Quality Guidelines. In young compost, the concentration of these chemical families decreased over time and most compounds were below the detection limits after 24 weeks of composting. In raw DPS, among the phenol, halogenated and monoaromatic hydrocarbons, dioxin and furan, and polychlorinated biphenyl families, most compounds were below the detection limits. The raw DPS and its young compost do not represent a major threat for the environment but can require an environmental follow-up. Reproduced with permission from the CAB Abstracts database.

649. Examination of the contaminants and performance of animals fed and bedded using de-inking paper sludge.

Beauchamp, C. J.; Boulanger, R.; Matte, J.; and Saint Laurent, G.

Archives of Environmental Contamination and Toxicology 42(4): 523-528. (2002); ISSN: 0090-4341

Descriptors: aluminium/ broilers/ copper/ litter/ paper mill sludge/ polycyclic hydrocarbons/ poultry/ tissue distribution/ aluminum/ chickens/ domesticated birds/ hogs/ swine

Abstract: In the noncereal-producing areas, there is not enough straw to supply the amount required for animal bedding. However, pulp and paper mills produce tonnes of wood fibre wastes, including de-inking paper sludge (DPS), in which most toxic compounds are at their detection limit. Among the detected compounds in DPS, aluminium, copper and polycyclic aromatic hydrocarbons (PAHs) are present and were selected as model molecules. In this context, broilers were submitted to a diet containing 0, 5, and 10% of their ration as DPS. In addition, broilers and pigs were grown on de-inking paper sludge and wood shavings beddings. The presence of aluminium and copper were evaluated in blood and bones, whereas the presence of PAHs was evaluated in fat, liver, meat and urine or blood of broilers and pigs. Animal performances were also investigated. DPS bedding did not increase aluminium or copper contents of blood or bones or PAHs in animal tissues. Animal performances and health were similar on DPS and wood shaving beddings. Using DPS as bedding material provides an integrated source of disposal of DPS and animal manure.

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650. Experiences with the utilization of wastes in nursery potting mixes and as field soil amendments.

Chong, C.

Canadian Journal of Plant Science 79(1): 139-148. (1999)
NAL Call #: 450 C16; ISSN: 0008-4220

Descriptors: animal wastes/ apple pomace/ bark/ composting/ food/ growing media/ industrial wastes/

marginal land/ mushroom compost/ organic wastes/ ornamental plants/ paper mill sludge/ plant residues/ planting stock/ refuse compost/ rehabilitation/ research/ reviews/ shade trees/ soil amendments/ trees/ wood chips/ woody plants/ livestock wastes/ nursery plants / nursery stock/ ornamentals/ planting materials/ potting composts/ rooting media/ studies/ town compost

Abstract: The nursery/landscape industry has been one of the fastest growing agricultural sectors in Canada. Since the 1980s, the Ornamental Nursery Research Program at the Horticultural Research Institute of Ontario (HRIO) has been conducting research which focuses on environmentally friendly production practices. Emphasis is on the use of composted or uncomposted organic wastes as amendments in container potting mixes. The results of the research programme are reviewed. Various projects have evaluated mixes derived from wastes such as spent mushroom compost, paper mill sludge, apple pomace, and various types of barks. In the late 1980s and early 1990s, the scope of the research expanded to include composting and a wider assortment of wastes such as waxed corrugated cardboard, municipal solid waste compost, wood chips from pallets and furniture and demolition wastes, food wastes, and organic fertilizers manufactured from meat by-products, and selected industrial wastes. Presently, paper mill sludge is being evaluated as a field soil amendment for growing nursery shade trees and also for use in rehabilitating marginal, non-agricultural land. Reproduced with permission from the CAB Abstracts database.

651. Experiences with wastes and composts in nursery substrates.

Chong, C.

HortTechnology 15(4): 739-747. (2005)

NAL Call #: SB317.5.H68; ISSN: 1063-0198

Descriptors: agricultural wastes/ animal manures/ composts/ container grown plants/ growing media/ industrial wastes/ nurseries/ organic amendments/ paper mill sludge/ plant residues/ refuse/ wastes/ farm wastes/ municipal wastes/ potting composts/ rooting media/ trash

Abstract: During the past 20 years, the Ornamental Nursery Research Program at the former Horticultural Research Institute of Ontario (now part of the University of Guelph) has been conducting applied research dealing with environmentally friendly and sustainable nursery production practices with emphasis on container production. The use of farm, industrial, and consumer waste by-products as amendments in nursery substrates has been a major focus. The program has evaluated hundreds of potting mixes derived from individual or combined, raw or composted waste by-products including spent mushroom compost, turkey litter compost, paper mill sludge, municipal waste compost, corrugated cardboard, apple pomace, wood chips from pallets, pulverized glass, and various types of tree barks. With few exceptions, all the above waste by-products tested under our cultural conditions provided acceptable to excellent container-growing media, often in amounts exceeding 50% and sometimes up to 100% by volume in No. 2 containers (6 L), even despite initially elevated and potentially toxic contents of soluble salts [expressed in terms of electrical conductivity measured up to 8.9 dS.m⁻¹ in 1 substrate: 2 water (by volume) extracts] in many of the substrates. A key to these successful results

is that salts leach quickly from the containers to benign levels (~1.0 dS.m⁻¹) with normal irrigation practices. High initial pH in most waste-derived substrates (up to 8.9) has had little or no discernible effect on growth of a wide assortment of deciduous nursery species. By-products such as paper mill sludge and municipal waste compost with soluble salts contents typically ranging from 0.8 to 2.0 dS.m⁻¹, also provide acceptable rooting media provided salts are leached before use to values <=0.2 dS.m⁻¹. The porosity and aeration characteristics of waste-derived substrates tend to be comparable to, or better than, those of bark.

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652. Exploring the value of sludge.

Lagace, Pascale; Steinback, Brian; Bourdages, Gaetan; and Levis, Cathy. Vol. Pt B. Montreal, Can: CPPA; 1998.

Notes: Chapter Number: Montreal, Canada
Conference code: 48341.

Descriptors: composting/ cost effectiveness/ costs/ drying/ economic and social effects/ land fill/ sewage sludge/ sludge disposal/ waste incineration/ anaerobic conditioning/ sludge dryer/ sludge management/ paper and pulp mills

Abstract: Abitibi-Price performed an evaluation of the sludge management practices for six mills with activated sludge treatment systems to identify which mills could best benefit from capital spending for sludge management, and how it should be used to provide the greatest company-wide benefit. The effluent treatment and sludge dewatering systems, as well as the sludge disposal methods were reviewed at each mill in order to identify ways of reducing operating costs and environmental liabilities. The sludge management alternatives evaluated included combinations of improved dewatering, drying, combustion, agricultural or silvicultural land spreading, composting and landfilling. As part of the project, anaerobic conditioning, a new, low-cost technology to reduce biological sludge production, was also reviewed. The various sludge management options were evaluated on the basis of return on investment, long-term sustainability, social impact and technological feasibility. The best options for each mill were selected using criteria developed for the specific mill. These options were then compared overall to determine which opportunities presented the greatest benefit to the company and should be explored further. Two projects were selected for more detailed study: the anaerobic conditioning project at Alma and the installation of a sludge dryer at the Beupre mill.
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653. Growing substrates amended with raw or composted paper mill primary sludge.

Dubsky, M and Sramek, F
Zahradnictvi Horticultural Science. 1999; 26(3): 103-106(1999)

Descriptors: bark/ chrysanthemums/ composts/ growing media/ nutrient deficiencies/ ornamental herbaceous plants/ ornamental plants/ paper mill sludge/ peat/ plant nutrition/ pot plants/ Balsaminales/ Dendranthema morifolium/ ornamentals/ potting composts/ rooting media/ Saxifragales
Abstract: Peat-bark growing substrates amended with 33.3% by volume of paper mill primary sludge, raw or composted with decomposed bark (3 or 6 weeks), were

tested in experiments in 1998 with 3 pot plant species (New Guinea Impatiens, Dendranthema grandiflora [D. morifolium] and Kalanchoe blossfeldiana). As a control, peat-bark substrate was used. All prepared substrates had suitable physical and chemical properties; the substrates with primary sludge were only higher in pH and in calcium content. Tested plant species did as well in the substrates with composted primary sludge as in the control substrate. However, in the substrate with raw primary sludge, growth retardation and nutrient deficiency symptoms were observed in Impatiens. The experiments with all 3 species showed the possibility of using paper mill primary sludge as a substrate component after composting with decomposed bark for at least 3 weeks.

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654. Growth and nutrient concentrations in the lettuce tissue by lime and paper residues application in an acid soil .

Balbinot Junior, A. A.; Torres, A. N. L.; Fonseca, J. A. da; and Teixeira, J. R.

Revista de Ciencias Agroveterinarias 5(1): 9-15. (2006); ISSN: 1676-9732.

Notes: Original title: Crescimento e teores de nutrientes em tecido de alface pela aplicacao de calcario e residuos de reciclagem de papel num solo acido.

Descriptors: acid soils/ application rates/ application to land/ biomass/ boron/ cadmium/ calcium/ chromium/ copper/ growth/ heavy metals/ iron/ lead/ lettuces/ lime/ liming/ magnesium/ manganese/ mercury/ mineral content/ nickel/ nitrogen/ nutrient content/ organic amendments/ paper mill sludge/ phosphorus/ plant composition/ plant tissues/ potassium/ sodium/ soil acidity/ soil amendments/ soil types/ sulfur/ waste utilization/ zinc/ chemical constituents of plants/ elemental sulphur/ land application/ Mn/ sulphur

Abstract: The residues produced by paper recycling industries, commonly known as paper mill sludge, present some constituents that can correct soil acidity and act as nutrients source, mainly calcium. However, these residues may also have heavy metals, which can cause environmental impact. The aim of this work was to evaluate the effect of different rates of lime and two kinds of recycling paper industry residues on the growth and mineral composition (nutrients and heavy metals) of lettuce tissue. The effect of lime and two kinds of recycling paper industry residues, applied in five doses, on lettuce dry mass and lettuce tissue levels of nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, copper, zinc, iron, manganese, sodium, boron, cadmium, chromium, nickel, lead and mercury were evaluated. The application of lime and two kinds of recycling paper industry residues increased lettuce dry mass and did not affect lettuce tissue levels of nutrients and heavy metals concentration.

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655. Growth of corn in varying mixtures of paper mill sludge and soil.

O' Brien, T. A.; Herbert, S. J.; and Barker, A. V.
Communications in Soil Science and Plant Analysis 33(3-4): 635-646. (2002)
NAL Call #: S590.C63; ISSN: 0010-3624 [CSOSA2]

Descriptors: Zea mays / seed germination/ seedling emergence/ dry matter accumulation/ nitrogen content/ phosphorus/ nutrient content/ nitrogen fertilizers

Abstract: To evaluate different levels of paper mill sludge as a soil amendment for the production of corn (*Zea mays* L.), sludge was added to 15-cm pots of soil in a greenhouse experiment. Mixtures were made from paper mill sludge (0 to 560 Mg ha⁻¹ wet weight) mixed with field soil (Hadley fine sandy loam with coarse, mixed, mesic, Fluventic, Dystrochrept deposits). Nitrogen (N) was added as ammonium nitrate at 0 or 200 kg N ha⁻¹. Eight corn seeds of 'Pioneer Max 21' were seeded into each pot immediately after mixing the paper mill sludge and soil or at 21 days after mixing the media. Seven days after sowing, seedlings were counted in each pot to assess germination (emergence). Delaying of sowing of seeds for 21 days increased the number of seeds that germinated. Corn plants were harvested after 35 days of growth. Plant biomass declined as amounts of sludge increased. Adding N and delaying sowing for 21 days produced the greatest amount of dry mass. Tissue (leaf) total N decreased with increasing amounts of sludge. Addition of N to the mixtures increased the average total N in corn leaves. However, leaf total N still decreased with increasing amounts of sludge added even if N at 200 kg ha⁻¹ was added to the media. Sowing immediately after setup showed the highest leaf total N if no sludge was added to the mixture. Sowing immediately after setup of the experiment and adding paper mill sludge at 560 Mg ha⁻¹ produced the lowest total N in corn leaves. Generally, the phosphorus (P) concentration in plants increased as the amount of paper sludge increased, but the increase was less with N added than in treatments without N added. At 21 days, carbon:nitrogen, pH, and salinity of the media declined relative to the initial values. Total N in the media was higher after a 21-day delay than immediately after setup. Organic matter content increased with increasing amounts of paper sludge. Results indicated that addition of paper sludge to soil increased media organic matter and P contents. Germination was hindered when seeds were sown immediately after setup of the experiment, but delaying seeding for 21 days eliminated the germination problem. Nitrogen deficiency was problematic, and more than 200 kg ha⁻¹ of supplemental N is recommended to overcome immobilization of N. This citation is from AGRICOLA.

656. Growth of evergreen shrubs in potting mixes made with de-inked paper sludge.

Tripepi, Robert R. and George, Mary W.
In: 97th Annual International Conference of the American Society for Horticultural Science. Lake Buena Vista, Florida, USA.; Vol. 35(3): 429.; 2000.

NAL Call #: SB1.H6

Descriptors: horticulture: agriculture/ waste management: sanitation/ Coniferopsida: gymnosperms, plants, spermatophytes, vascular plants/ Ericaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ Rosaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ de-inked paper sludge: potting mix/ plant growth: biomass, height, width

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657. Impact of de-inking paper sludge on crop yields and soil fertility.

Baziramakenga, R. and Simard, R. R.
In: 1999 Annual Meeting of the Canadian Society of Soil Science. Charlottetown, Prince Edward Island, Canada.; Vol. 79(4).; pp. 640; 1999.

NAL Call #: 56.8 C162

Descriptors: Horticulture: Agriculture/ Nutrition/ Waste Management: Sanitation/ Soil Science/ Leguminosae: Angiosperms, Dicots, Plants, Spermatophytes, Vascular Plants/ Crop Yield/ De-Inking Paper Sludge: Soil Amendment/ Environmental Safety/ Soil Fertility/ Abstracts © Thomson Reuters

658. Impact of industrial effluents on soil health and agriculture. Indian experience: Part I. Distillery and paper mill effluents.

Chhonkar, P. K.; Datta, S. P.; Joshi, H. C.; and Pathak, H.
Journal of Scientific and Industrial Research 59(5): 350-361. (2000)

NAL Call #: 475 J82; ISSN: 0022-4456

Descriptors: application to land/ chemical composition/ distillery effluent/ effluents/ irrigation water/ paper mill sludge/ rivers/ soil amendments/ soil properties/ waste water/ land application

Abstract: In India, a large amount of waste water generated from distillery and paper industries is discharged on land or into the running water. Distillery waste water is characterized by low pH, high BOD [biochemical oxygen demand] and COD [chemical oxygen demand] values and contains a high percentage of organic and inorganic materials. This waste water also contains considerable amounts of elements like N, P, K, Ca and S. The paper mill effluents are characterized by high values of BOD, COD and wide range of pH, depending upon the source of origin. The N, P and K contents are lower as compared to those in distillery waste waters. Impact of use of these effluents on soil, plant and waterbodies is discussed. Use of distillery effluents indicates a significant increase in electrical conductivity, organic carbon, exchangeable Na as well as available N, P and K in soils. Similarly, pH, organic carbon, cation-exchange capacity, available N, P, K and micronutrient contents of soils irrigated with paper factory effluents are reported to be increased. Besides, the use of this waste water increases the exchangeable Na content of soils. Some of the field crops show positive response to post-methanation effluent application with irrigation water. Paper mill effluents are found to adversely affect the seed germination and seedling growth of various crops, whereas, these aspects of crops are stimulated due to the application of these effluents after proper dilution. Increase in organic load, depletion of oxygen content and destruction of aquatic life in water course are some of the major problems created due to disposal of these effluents in river. Methods of control and treatment of these effluents are indicated. Manurial potential, strategies and constraints of utilization of these industrial effluents in agriculture are mentioned. Reproduced with permission from the CAB Abstracts database.

659. Impact of paper mill effluent on seed germination and seedling growth of phaseolus aureus cv. Pant m -4.

Kumar, S.
Flora and Fauna (Jhansi) 11(2): 189-193. (Dec. 2005); ISSN: 0971-6920

Descriptors: effluents/ fauna/ germination/ growth/ industrial wastewater/ inhibition/ pulp and paper industry/ seedlings/ seeds

Abstract: The study was carried out to see the impact of paper mill effluent on germination percentage and seedling growth of *Phaseolus aureus* cv. Pant M-4. The studies were done with different concentrations of effluent. The results showed that lower concentration was in favour of germination and seedling growth while there was gradual decrease in germination and seedling growth on higher concentration. The maximum inhibition both in seed germination and seedling growth was found in pure effluent. Abstract reproduced from the Water Resources Abstracts database with permission from ProQuest LLC. © 2007 ProQuest LLC; all rights reserved. Further reproduction is prohibited without permission.

660. Impact of paper mill industry effluent on germination and early growth performance of some medicinal plants.

Sandhya Sharma and Kavita Tyagi

Plant Archives 7(1): 261-263. (2007); ISSN: 0972-5210

Descriptors: industrial effluents/ industrial wastes/ medicinal plants/ paper mill sludge/ roots/ seed germination/ seedling growth/ seedlings/ seeds/ shoots/ soil amendments/ waste management/ waste utilization/ drug plants/ medicinal herbs/ officinal plants/ *Solanum virginianum*

Abstract: This paper summarizes the effects of various concentrations of the paper mill effluent on seed germination and seedling growth of *Calotropis procera* and *Solanum xanthocarpum*. The effluent samples were collected from Pragati Paper Mill Industry Pvt. Ltd., Site-IV, Sahidabad, Uttar Pradesh, India, and diluted to 25, 50 and 100%. The germination was completely inhibited in 100% concentration upto 7th day but slight germination and seedling growth was observed in both the plants on 9th day after sowing. The findings also revealed that the shoot length, root length, fresh weight and dry weight of the selected medicinal plants were maximum in 25% effluent concentration on 5th, 7th and 9th day but not more than control.

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661. Impact of paper mill treated effluent irrigation and solid wastes amendment on the productivity of Cumbu napier (co. 3): A field study.

Devakumari, M. S. and Selvaseelan, D. A.

Asian Journal of Experimental Sciences 22(3): 285-293. (2008); ISSN: 0971-5444

Descriptors: effluents/ fodder/ grasses/ impaired water use/ industrial wastewater/ pulp and paper industry/ solid wastes/ wastewater irrigation/ yield

Abstract: In this investigation productivity of Cumbu Napier (CO- 3) fodder grass under effluent irrigation and solid waste application was evaluated. The field experiment with solid waste incorporation coupled with effluent irrigation for Cumbu Napier grass revealed that effluent irrigation increased the biomass yield of the grass by 7.35 % in the second harvest and 10.35 % in the third harvests over well water irrigation, even though, lower yield was obtained in the first harvest due to initial establishment problem under effluent irrigation. This suggests that growing Cumbu Napier grass under treated paper mill effluent for enhanced

fodder production to support dairy units is a viable option which needs a positive consideration. The increase in grass biomass yield under I₂T₄ (Effluent irrigation coupled with Fly ash 10 t ha⁻¹ + Bio sludge 6t ha⁻¹ + 75% NPK over I₁T₁(100% NPK) was 44.7 percent during II cutting and 52.6 percent in III cutting. The soil available N, and organic carbon were also significantly the highest under Fly ash 10 t ha⁻¹ + Bio sludge 6 t ha⁻¹ + 75% NPK treatment as compared to 100% NPK alone.

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662. Impact of potato-cereal rotations and slurry applications on nitrate leaching and nitrogen balance in sandy soils.

Gasser, M. O.; Laverdiere, M. R.; Lagace, R.; and Caron, J. *Canadian Journal of Soil Science* 82(4): 469-479. (2002)

NAL Call #: 56.8 C162 ; ISSN: 0008-4271

Descriptors: arable soils/ barley/ cattle manure/ crop production/ environmental impact/ groundwater/ groundwater pollution/ leaching/ nitrate/ nitrogen balance/ nitrogen fertilizers/ nutrient uptake/ oats/ paper mill sludge/ pig slurry/ potatoes/ risk assessment/ rotations/ sandy soils/ soil types/ water quality/ wheat/ crop rotation/ environmental effects/ rotational cropping/ water composition and quality

Abstract: Groundwater quality is at risk when high levels of N fertilizers are used on sandy soils. A monitoring programme was initiated in the summer of 1995, to quantify nitrate leaching in sandy soils used for potato production near Quebec City, Canada. Three drainable lysimeters were installed in each of five fields, for a total of 15 lysimeters. During a 5-year monitoring period, crop N uptake, mineral and organic N fertilizers use, nitrate concentrations and fluxes from drainage water at 1-m soil depth were assessed under potato, cereal and hay crops. In one field, a clover and timothy sod that received low mineral N fertilizer inputs generated the lowest annual nitrate leaching losses ranging from 7 to 20 kg NO₃-N ha⁻¹. High nitrate leaching losses (116±40 kg N ha⁻¹) were measured under potato crops receiving high mineral N fertilizer inputs. Cereals, including barley and wheat receiving moderate mineral N fertilizer inputs and in some instance N from pig slurry, dairy cow manure or paper mill sludge, also generated high nitrate leaching losses (88±45 kg N ha⁻¹). Only sod and oat crops generated annual flux averaged nitrate concentrations lower than 10 mg NO₃-N litre⁻¹, the accepted standard for drinking water, while higher concentrations, ranging from 13 to 52 mg NO₃-N litre⁻¹, were recorded under barley, wheat and potato crops receiving moderate to high amounts of mineral N fertilizer. Nitrate flux concentrations were moderate during the cropping season (May-August), highest in autumn (September-December) and lowest in the winter-early spring period (January-April). After 5 years of survey, use of pig slurry and paper mill sludge in potato-cereal crop rotations (51 to 192 kg N ha⁻¹ per year) with mineral N fertilizers (103 to 119 kg N ha⁻¹ per year) resulted in nitrate leaching losses (87 to 132 kg N ha⁻¹ per year), at least 20 kg N ha⁻¹ more than N exported by crop at harvest. More than 60% of N applied as pig slurry seemed to be unaccounted for in the partial N balance that included crop N uptake and nitrate leaching, suggesting that

important losses probably occurred through ammonia volatilization, denitrification, or N immobilization in soil organic matter and crop residues.

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663. Impact of raw and composted paper mill sludge on potato disease incidence.

Stone, A. G.; Stevenson, W. R.; James, R. V.; and Cooperband, L. R.

In: Annual Meeting of the American Phytopathological Society. Montreal, Quebec, Canada.; Vol. 89 (6 Suppl.); pp. S75-S76; 1999.

Descriptors: horticulture: agriculture/ infection/ pest assessment control and management/ enterobacteriaceae: bacteria, eubacteria, microorganisms/ solanaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ aerial black leg/ bacterial disease/ early blight/ fungal disease/ silver scurf/ fungal disease/ paper mill sludge: composted material, raw material, disease impact/ meeting abstract

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664. Improvement of soil properties and fruit yield of native lowbush blueberry by papermill sludge addition.

Gagnon, B.; Simard, R. R.; Lalande, R.; and Lafond, J.

Canadian Journal of Soil Science 83(1): 1-9. (2003)

NAL Call #: 56.8 C162 ; ISSN: 0008-4271

Descriptors: acid phosphatase/ application rates/ arylsulfatase/ chemical composition/ crop yield/ enzyme activity/ fertilizers/ fruits/ leaching/ manganese/ nitrate nitrogen/ paper mill sludge/ phosphorus/ Podzols/ soil amendments/ soil chemical properties/ soil composition/ soil enzymes/ soil fertility/ soil ph/ waste management/ waste utilization/ acid phosphomonoesterase/ arylsulphatase/ chemical properties of soil/ inorganic nitrogen/ Mn

Abstract: Combined primary and secondary papermill sludge (PS) is a good potential source of C and other nutrients to restore low organic matter sandy soils supporting native lowbush blueberry (*Vaccinium angustifolium* Ait.). A 3-yr field study was conducted to compare the effect of PS with mineral fertilizers (MF) on the blueberry yield and soil chemical properties and enzyme activities of a l'Afrique sand (Humo-Ferric Podzol) in the Saguenay-Lac Saint-Jean area (Quebec, Canada). The PS was applied in the spring of the sprout year at 0, 8.5, 17 and 34 Mg ha⁻¹ and MF was applied at 0, 13, 26 and 52 kg N ha⁻¹. The highest fresh fruit yields were obtained at 8.5 and 17 Mg PS ha⁻¹. The 34 Mg PS ha⁻¹ treatment produced berry yield comparable to the control. This PS rate reduced pH, but increased inorganic N, Mehlich-3 extractable P and Mn in the 0- to 15-cm soil layer. The NO₃--N content of the 15- to 30-cm and 30- to 60-cm soil layers was also increased by PS, suggesting leaching. The MF significantly affected soil inorganic N content only at 3 wk after its application in the first year. The PS rate linearly increased the soil acid phosphatase activity in the first year. The arylsulfatase activity was also higher in PS than in MF treatment, but was severely depressed by 34 Mg PS ha⁻¹ in the last 2 yr. This study indicated that PS, when used at low rates, improves lowbush blueberry yield and the soil enzyme activity on this low fertility sand.

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665. Incorporation of organic residues to peat-lite substrates for production of impatiens and geraniums.

Gauthier, Fabienne; Gagnon, Serge; and Dansereau, Blanche

Canadian Journal of Plant Science 78(1): 131-138. (1998)

NAL Call #: 450 C16; ISSN: 0008-4220

Descriptors: Horticulture: Agriculture/ Balsaminaceae: Angiosperms, Dicots, Plants, Spermatophytes, Vascular Plants/ Geraniaceae: Angiosperms, Dicots, Plants, Spermatophytes, Vascular Plants/ subirrigation: irrigation method/ Crop Industry/ Composted Waste/ Growth/ Peat Moss/ Peat Lite Substrate/ Water Treated Sludge

Abstract: During winter 1994 and spring-summer 1994, seedlings of *Impatiens wallerana* 'Accent Coral' and *Pelargonium X hortorum* 'Orbit Hot Pink' were grown in a commercial substrate (PRO-MIX 'BX') or in one of 24 substrates composed of perlite (35% by volume), peat moss and of six organic residues (composted water-treated sludge, forestry compost, fresh or composted used peat extracted by biofilter during treatment of municipal water, and fresh or composted paper sludge). The purpose of the study was to determine the maximal proportion of these residues to be incorporated into a peat substrate to obtain quality plants. Growth parameters (growth index, top dry weight, and visual quality) generally decreased with increasing proportion (5, 10, 25 or 40% per volume). During the winter experiment, growth of control plants was superior to growth of plants grown in substrates composed of residues. An incorporated proportion of 25% per volume was shown to be maximal for the production of impatiens and geraniums.

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666. The increase of iron phytoavailability in soils amended with paper mill sludge.

Calace, N.; Croce, G.; Petronio, B. M.; and Pietroletti, M.

Annali Di Chimica 96(3-4): 137-145. (2006)

NAL Call #: 385 AN7 ; ISSN: 00034592 [ANCRA].

Notes: doi: 10.1002/adlc.200690014.

Descriptors: iron/ atomic absorption spectrometry/ barley/ bioavailability/ conference paper/ metabolism/ plant root/ sensitivity and specificity/ sewage/ soil/ textile industry/ biological availability/ hordeum/ iron/ plant roots/ sensitivity and specificity/ sewage/ soil/ spectrophotometry, atomic/ textile industry / hordeum vulgare subsp vulgare

Abstract: In soils characterized by low organic matter and high pH values (7.5-8.59) iron availability to plants is limited even if the content of total Fe(III) is high. We have studied by *Hordeum distichum* plants the capability of paper mill sludge to increase the iron phytoavailable fraction in an alkaline soil. The effect of paper mill sludges adding to an iron-deficient soil was evaluated both considering the phyto-available fraction of iron and the distribution of organic carbon (hydrophobic, fulvic and humic carbon) in the soil before and after sludge adding. Iron concentration was determined in the different portions of *Hordeum distichum* plants grown on soils with and without paper mill sludges. Application of paper mill sludge induces an increase in the concentration of available Fe. This effect is probably due to the production of Fe chelators by soil microorganisms acting on sludge organic matter. The Fe chelators produced result in the solubilization of not soluble Fe-complexes present in the soil.

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667. Increasing cotton yield on drought-prone soils by mulching paper mill sludge.

Boquet, D. J. and Breitenbeck, G. A.

Louisiana Agriculture 42(2): 12-13. (1999); ISSN: 0024-6735

Descriptors: application methods/ application rates/ cotton/ decomposition/ fertilizers/ industrial wastes/ irrigation/ mulches/ mulching/ nitrogen fertilizers/ paper mill sludge/ sludges/ soil/ waste utilization/ mulching materials/ United States of America/ watering

Abstract: Methods of reducing excessive soil N immobilization when paper mill sludge is applied to fields of cotton grown at Macon Ridge, Winnsboro, Louisiana were investigated in 1996 and 1997. The advantage of paper mill sludge application was that it increased irrigation water infiltration and soil water-holding capacity. Paper mill sludge was applied at rates of 10 or 20 tons/acre with 0, 60, 120, 320 or 640 lbs N/acre, with irrigation. 320 lbs N was required for sludge decomposition and for the cotton crop, and this N rate was uneconomic and environmentally unacceptable. However, the highest cotton lint yields were obtained if the sludge was surface applied and a lower rate of N (80 lb) was injected below the mulch. Further irrigated trials with paper mill sludge and moderate N rates applied using the same technique in the very hot and dry year increased cotton yields by 30-35%.

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668. Influence of meliorants on colonization of sugarbeet roots by fungus vector of rhizomania.

Matsevetskaya, N. M.

Zashchita i Karantin Rastenii 3: 44. (2000)

Descriptors: crop yield/ fungal diseases/ industrial wastes/ infection/ oil refinery wastes/ paper mill sludge/ plant disease control/ plant diseases/ plant pathogenic fungi/ plant pathogens/ plant viruses/ soil/ soil amendments/ spread/ sugarbeet/ phytopathogens

Abstract: An increase in the incidence of rhizomania (beet necrotic yellow vein virus transmitted by *Polymyxa betae*), first observed on sugarbeet 25 years ago, is reported from the Ukraine. The effect of this disease on yield, the infection process, spread, biology and the dynamics of *P. betae* infestation of sugarbeet are outlined. Soil application of wastes from the oil-chemical industry and from paper manufacturing decreased the numbers of *P. betae* cysts and cystosori in soil and sugarbeet.

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669. Influence of paper mill sludges on corn yields and N recovery.

N'Dayegamiye, A.; Huard, S.; and Thibault, Y.

Canadian Journal of Soil Science 83(5): 497-505. (2003)

NAL Call #: 56.8 C162; ISSN: 0008-4271

Descriptors: application rates/ crop yield/ Gleysols/ maize/ nitrate nitrogen/ nitrogen fertilizers/ nutrient uptake/ paper mill sludge/ plant nutrition/ residual effects/ silt loam soils/ soil types/ use efficiency/ corn

Abstract: Mixed paper mill sludges are an important source of N for crop production. An estimate of direct and residual N recovery is necessary for their efficient management. A 3-yr field study (1997-1999) was conducted in central Quebec, Canada, to evaluate mixed paper mill sludges

(PMS) effects on corn (*Zea mays* L.) yields and N nutrition, N recovery and N efficiency. The effects of PMS on soil NO₃-N and total N levels were also determined. The study was situated on a silt loam Baudette soil (Humic Gleysol). The treatments included 3 PMS rates (30, 60 and 90 t ha⁻¹ on wet basis) applied alone or in combination with N fertilizer (90 and 135 kg N ha⁻¹, respectively, for 60 and 30 t ha⁻¹). Treatments also included a control without PMS or N fertilizer, and a complete mineral N fertilizer (180 kg N ha⁻¹) as recommended for corn. The previous plots were split beginning with the second year of the experiment, for annual and biennial PMS applications. Similar treatments as above were made on an adjacent site to evaluate N recovery under climatic conditions in 1999. In all years, PMS applied alone significantly increased corn yields by 1.5-5 t ha⁻¹, compared to the unfertilized control. However, corn yields and N uptake were highest from the application of PMS in combination with N fertilizer. Biennial PMS applications at 60 to 90 ha⁻¹ significantly increased corn yields and N uptake, which suggest high PMS residual effect; however, these increases were lower than those obtained with annual PMS applications. The N efficiency varied in 1997 from 13.0 to 15.4 kg grain kg N⁻¹ for mineral N fertilizer and ranged from 3 to 13.7 kg grain kg N⁻¹ for PMS, decreasing proportionally to increasing PMS rates. Apparent N recovery ranged from 13 to 19% in 1997 and from 10 to 14% in the residual year (1998), compared to 30 and 49%, respectively, for mineral N fertilizer. Depending on the PMS rate, N recovery varied from 13 to 21% in 1999. The results indicate high N supplying capacity and high residual N effects of PMS, which probably influenced corn yields and N nutrition. Annual PMS applications alone or combined with mineral N fertilizer had no significant effect on soil NO₃-N and total N levels. This study demonstrates that application of low PMS rate (30 t ha⁻¹) combined with mineral N fertilizer could achieve high agronomic, economic and environmental benefits on farms. Reproduced with permission from the CAB Abstracts database.

670. Influence of papermill sludge on growth of medicago sativa, festuca rubra and agropyron trachycaulum in gold mine tailings: A greenhouse study.

Green, S. and Renault, S.

Environmental Pollution 151(3): 524-531. (2008)

NAL Call #: QH545.A1E52; ISSN: 02697491 [ENPOE].

Notes: doi: 10.1016/j.envpol.2007.04.016.

Descriptors: biological stabilization/ gold mine tailings/ papermill sludge/ reclamation/ biomass/ crops/ gold mines/ pigments/ tailings/ agropyron trachycaulum/ bulk density/ festuca rubra/ medicago sativa/ papermill sludges/ photosynthetic pigments/ greenhouse effect/ gold/ alfalfa/ fertilizer application/ gold mine/ grass/ growth response/ photosynthesis/ phytomass/ sludge/ stabilization/ tailings/ agropyron/ alfalfa/ alkalinity/ biomass/ bulk density/ fertilization/ greenhouse/ mining/ nonhuman/ plant leaf/ plant root/ shoot/ sludge/ sludge treatment/ tall fescue/ agropyron/ biodegradation, environmental/ biomass/ canada/ ecology/ festuca/ gold/ industrial waste/ medicago sativa/ mining/ paper/ plant roots/ plant shoots/ sewage/ elymus trachycaulus trachycaulus/ festuca rubra/ medicago sativa

Abstract: A greenhouse study was undertaken to

determine the suitability of adding papermill sludge to neutral/alkaline gold mine tailings to improve the establishment of *Festuca rubra*, *Agropyron trachycaulum* and *Medicago sativa*. *Festuca rubra* root and shoot biomass and *A. Trachycaulum* shoot biomass were increased with papermill sludge amendment. The addition of papermill sludge and fertilizer drastically increased the shoot and root biomass of *M. sativa* (20-30 times) while *A. trachycaulum* and *F. rubra* showed a more moderate increase in growth. Photosynthetic pigment content of the leaves was higher in papermill sludge treatments than in the treatments without papermill sludge. The organic carbon content, macro-aggregate content and field capacity of the gold mine tailings were increased while the bulk density was decreased by the addition of papermill sludge. This study suggests that addition of papermill sludge and adequate fertilization can alleviate some of the adverse conditions of neutral/alkaline gold mine tailings. © 2007 Elsevier Ltd. All rights reserved.

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671. Influence of residue management and soil tillage on second rotation eucalyptus growth.

Dedecek, R. A.; Bellote, A. F. J.; and Menegol, O. *Scientia Forestalis/Forest Sciences*(74): 09-17. (2007); ISSN: 14139324.

Notes: Original title: Influência do manejo dos resíduos e dos sistemas de preparo do solo no crescimento de eucaliptos em segunda rotação. Language of Original Document: Portuguese.

Descriptors: paper and pulp sludge/ soil chemical properties/ soil penetrometer resistance/ soil physical properties/ wood ash/ biological materials/ fertilizers/ forestry/ harvesting/ soils/ paper and pulp sludge/ soil chemical properties/ soil penetrometer resistance/ soil physical properties/ wood ash/ waste management/ eucalyptus/ fertilizers/ harvesting/ sludge/ waste management

Abstract: Harvesting residue management can change many soil chemical and physical properties, considering the mechanical operations involved and the impact on the organic matter content of the soil. Soil tillage systems and the use of paper and pulp sludge and wood ash as fertilizers can help maintain productivity and reduce the effect of the harvesting system being used. This work was set up after harvesting a 12 year old commercial plantation of *Eucalyptus grandis* Hill ex Maiden, in the Mogi Guacẽsu district, State of Saõ Paulo, Brazil, on a red-yellow latosol with less than 25% of clay and low fertility level. The influence of removal and maintenance of tree harvesting residues, soil fertilization with pulp and paper residues, and soil tillage systems was tested on eucalypts tree development and on alterations of soil chemical and physical properties. Although the difference was not significant, tree growth (height and DBH) was greater with industrial residue addition compared to maintenance of harvesting residues on soil surface. Industrial residues added to soil changed the fertility capacity, increasing pH and Ca+Mg content, reducing H+Al content, and had a small effect on K and P levels. Keeping tree-harvesting residues on soil surface increased the water content available on surface layer, compared to soil where all residues had been removed. Reducing tillage had greater effect on tree growth than increasing the amount of waste

material added as fertilizer. Tilling a wider row for planting lines increased soil compaction at levels considered harmful for plant root growth.

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672. Influence of vermicompost on the growth and yield of black gram (phaseolus mungo).

Umamaheswari, S. and Vijayalakshmi, G. S. *Ecology, Environment and Conservation* 12(1): 53-56. (2006)

NAL Call #: QH183.E238; ISSN: 0971765X [EECOF]
Descriptors: cow dung / eudrilus eugeniae/ paper mill sludge/ phaseolus mungo/ vermicompost/ composting/ growth response/ industrial waste/ sludge/ vermiculture/ yield response/ eudrilus eugeniae/ vigna mungo

Abstract: The present work aims to utilize industrial waste (paper mill sludge) for vermiculture, which give value added vermicompost to the input for the organic agriculture to save the soil from chemicals and to produce more. Based on the previous works and recommendations epigeic earthworm species *Eudrilus eugeniae* was selected for decomposition. Studies have been-made to ascertain the physical and chemical characterization of the paper mill sludge + cow dung mixture before and after composting. Further, a plant growth study on black gram is also carried out. The analysis of physico chemical properties of vermicompost shows that the pH was uniformly brought to neutral level and insignificant increase of EC was recorded. The chemical analysis of the vermicompost clearly indicated that the compost was rich in N, P, K, essential Carbon and C:N ratio during vermicomposting is the main index to assess the rate of organic matter decomposition. With regard to growth studies of black gram (*Vigna mungo*) was carried out employed it was observed that the morphological and yield parameters were found to increase significantly ($P < 0.05$) over control. Copyright © Enviromedia.

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673. Influences of lignin from paper mill sludge on soil properties and metal accumulation in wheat.

Zhang, S.; Wang, S.; Shan, X. Q.; and Mu, H. *Biology and Fertility of Soils* 40(4): 237-242. (Sept. 2004)
NAL Call #: QH84.8.B46; ISSN: 0178-2762

Descriptors: bioaccumulation/ soil pollution/ soil amendments/ phosphorus/ potassium/ fractionation/ soil chemical properties/ pulp and paper mill effluents/ copper/ zinc/ cadmium/ lead/ chromium/ nickel/ China

Abstract: The influences of lignin application on soil properties of three different soils, Jiangxi soil (Ultisol, Hapludult), Heilongjiang soil (Alfisol, Entioboralf) and Beijing soil (Alfisol, Haplustalf), and metal accumulation in wheat (*Triticum aestivum* L.) were studied in a pot experiment. By lignin amendment, soil pH, organic matter (OM) and cation exchange capacity (CEC) increased, except for CEC in the Beijing soil. Analysis showed that available P and K in lignin-amended soils were also elevated, except for P in the Jiangxi soil. A three-step sequential extraction procedure proposed by the Standards, Measurements and Testing Programme (formerly BCR) of the European Commission was used to investigate the fraction redistribution of heavy metals in soils with lignin application. The fractions were specified as

B1: water soluble, exchangeable and carbonate bound, and weakly adsorbed; B2: Fe-Mn oxide bound; and B3: organic matter and sulfide bound. Generally, the heavy metal content of the B2 fraction decreased whereas that of the B3 fraction increased. Lignin application to arable soils can not only improve plant growth in vitro, but also reduce the accumulation of the heavy metals Cu, Zn, Cd, Pb, Cr and Ni in wheat plants.

This citation is from AGRICOLA.

674. Investigations of paper mill sludge as a component of container medium.

Ou Yang Wei and Wu WenShi

Plant Pathology Bulletin 11(1): 19-24. (2002); ISSN: 1021-9544

Descriptors: chlorophyll/ composts/ growth/ leaves/ paper mill sludge/ peat/ roots/ seed germination/ seedlings

Abstract: Paper mill sludge (PMS), commercial peat and a commercial container medium (BVB No. 4) were compared in the greenhouse for use as container media. Composted PMS mixed with peat at ratio of 80% PMS (volume basis) supported plant growth, and relative leaf chlorophyll content of periwinkles comparable to commercial container medium (BVB No. 4). Container medium amended with 50% composted PMS supported similar or better growth of ten different plant species than BVB No. 4, except the root length of cosmos and chrysanthemum. Raw PMS supernatant inhibited seed germination of periwinkle. The inhibitory effect was eliminated when the raw PMS was well composted. Composted PMS was compatible with the amended antagonistic microorganism and was good for production healthy periwinkle seedlings.

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675. Kraft mill sludge to improve vegetal production in chilean andisol.

Gallardo, F.; Mora, M. L.; and Diez, M. C.

Water Science and Technology(6): 31-37. (2007); ISSN: 02731223 [WSTED].

Notes: doi: 10.2166/wst.2007.209.

Descriptors: andisol soil/ sludge application/ vegetal production/ biomass/ greenhouses/ microbiology/ nutrients/ paper and pulp mills/ soils/ kraft mill sludge/ sludge application/ vegetal production/ sludge disposal/ calcium/ carbon dioxide/ magnesium/ phosphorus/ potassium/ biomass/ greenhouses/ microbiology/ nutrients/ paper and pulp mills/ sludge disposal/ soils/ andisol/ biomass/ greenhouse effect/ sludge/ toxicity/ volcanic ash/ wheat/ activated sludge/ biomass production/ chile/ conference paper/ controlled study/ germination/ greenhouse/ nutrient content/ plant growth/ plant root/ soil pollution/ temperature dependence/ vegetation/ volcanic ash/ wheat/ biomass/ carbon dioxide/ chile/ crops, agricultural/ particulate matter/ plant components, aerial/ plant roots/ seeds/ sewage/ soil pollutants/ triticum/ volcanic eruption/ biomass/ greenhouses/ kraft mills/ microbiology/ nutrients/ sludge disposal/ soil/ triticum aestivum

Abstract: The effect of kraft mill sludge addition (25 to 75 ton/ha) to soil derived from volcanic ashes (Andisol) on wheat (*Triticum aestivum* L.cv. Puken) biomass production, and in the nutrient absorption by the plants was evaluated. Respiration activity and seed germination tests were carried out on the soil/sludge mixtures, in order to evaluate possible toxic effects due to the sludge addition to the soil.

Soil without sludge was used as a control treatment. The plants were grown in a greenhouse (25°C, 14 h-photoperiod) during 120 days, then the plants were collected and dried at 65°C for 72 h for the determination of biomass production (root and aerial) and analyzed for mineral content (Ca, Mg, K and P). The mixtures of soil/sludge showed no toxicity. Seed germination and respiration activity increased with the increment of the sludge. The accumulated CO₂ in the soil without sludge was 41.66 mg CO₂/100; this value shows a low microbial activity. The biomass increased with the increment of sludge addition to the soil and five times more biomass was obtained when 75 ton/ha sludge was added to the soil. The nutrient absorption efficiency was also improved with the sludge addition. © IWA Publishing 2007.

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676. Land application of mechanical pulp mill sludges in Alberta: Research and operational activities.

Macyk, Terry M. Vol. 2.

Vancouver, Can: TAPPI Press; pp. 569-578; 1998.

Notes: Chapter Number: Norcross, GA, United States Conference code: 48747.

Descriptors: crops/ cultivation/ environmental impact/ environmental protection/ frozen soils/ harvesting/ sludge disposal/ standards/ lodgepole pine/ mechanical pulp mill sludges/ sludge amended haul road soils/ white spruce/ paper and pulp mills

Abstract: Research regarding land application of mechanical mill sludges was undertaken by the Alberta Research Council in June 1991. The objective of the research is to provide industry, government regulators and the public with information on the impact of sludge application on agricultural and forest land and to provide a basis for adopting operational landspreading guidelines. The results of detailed sludge characterization work, greenhouse studies, decomposition work and column leaching studies demonstrated that land application was feasible and provided guidance for implementation of relevant and practically designed field studies. Two field trials were established to evaluate the impact of single and multiple applications of sludges from different mills on agricultural crops and soil quality in 1992 and 1993 and are monitored to obtain long-term data relative to crop yields and soil quality. The sludge amended treatments have demonstrated yield increases from two-to-five-fold greater than control and that increased yields have been sustained for at least five growing seasons. Three experiments were established in the forest beginning in 1993. The first involved application and incorporation of four rates of two sludge types in a replicated experiment on a recently harvested cut-block. Height and diameter increases up to 2.5 fold for white spruce (*Picea glauca*) and lodgepole pine (*Pinus contorta* var. *latifolia*) seedlings planted in the sludge amended plots compared to the control plots have been observed during the past five growing seasons. Another experiment involved application of three rates of sludge on frozen and non-frozen soil on haul roads, borrow areas, and wellsites to assess the efficacy of the sludge in reclaiming disturbed areas in the forest and returning forest productivity. The bulk density of the sludge amended haul road soils was reduced by 30%, soil water holding capacity was increased by 25% and lodgepole pine seedling growth increased three-fold over control treatments.

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677. Land application of mechanical pulp mill sludges in Alberta: Research and operational activities. Deinked and non-deinked sludges are beneficial in soil application.

Macyk, T. M.

Pulp and Paper Canada 100(6): 34-37. (1999); ISSN: 0316-4004

Descriptors: application rates/ application to land/ crop yield/ crops/ paper mill sludge/ research/ sludges/ soil fertility/ yields/ land application/ studies

Abstract: Research into the land application of mechanical pulp mill sludges was undertaken in June 1991. The results of detailed sludge characterization work, greenhouse studies, decomposition work and column leaching studies showed that land application was feasible, and this conclusion led to the implementation of field studies. Field trials to evaluate the effects of single and multiple applications of sludges on agricultural crops and soil quality have demonstrated yield increases from two-to-five-fold greater than control. These trials have also shown that increased yields have been sustained for at least five growing seasons. Experiments established in the forest have demonstrated height and diameter increases up to 2.5-fold for white spruce (*Picea glauca*) and lodgepole pine (*Pinus contorta* var. *latifolia*) seedlings planted in the sludge-amended plots compared to the control plots. Reproduced with permission from the CAB Abstracts database.

678. Leachability of metals in fly ash from a pulp and paper mill complex and environmental risk characterisation for eco-efficient utilization of the fly ash as a fertilizer.

Poykio, R.; Nurmesniemi, H.; Peramaki, P.; Kuokkanen, T.; and Valimaki, I.

Chemical Speciation and Bioavailability 17(1): 1-9. (2005); ISSN: 0954-2299

Descriptors: arsenic/ barium/ bioavailability/ cadmium/ chromium/ cobalt/ copper/ environmental degradation/ fly ash/ heavy metals/ leaching/ lead/ liming materials/ nickel/ polluted soils/ potassium/ pulp and paper industry/ pulp mill effluent/ risk/ risk assessment/ soil amendments/ soil degradation/ soil pollution/ soil types/ titanium/ vanadium/ waste management/ waste utilization/ zinc/ kraft mill effluent/ paper industry

Abstract: A five-stage, sequential leaching procedure was used to determine the distribution of metals (Cd, Cu, Pb, Cr, Zn, Ni, Co, As, V, Ba, Ti and K) in fly ash from a pulp and paper mill complex between the water-soluble fraction (H₂O), exchangeable fraction (CH₃COOH), easily reduced fraction (HONH₃ Cl), oxidizable fraction (H₂O₂+CH₃COONH₄), and the residual fraction (HF+HNO₃+HCl). The possible environmental risk associated with the eco-efficient utilization of fly ash as a fertilizer, especially the Cd load, was estimated. In addition, the mobility (i.e. bioavailability) of Cd, Cu, Pb, Zn, Ni and Cr was evaluated. The fly ash was derived from an electrostatic precipitator of a fluidized bed boiler in the co-combustion (55% bark and wood residues, 45% peat) process at pulp and paper mill in Northern Finland. The accuracy of the leaching procedure was tested using a certified reference material SRM 1 633b (Coal Fly Ash). The metals were determined by graphite furnace atomic absorption spectrometry (GFAAS) or by inductively coupled plasma atomic emission spectrometry (ICP-AES). The

mobility factors (i.e. bioavailability) of the metals followed the order: Cd, Cu, Zn, Ni, Pb and Cr. The fly ash from the pulp and paper mill was enriched in Ca, Mg, P and K, and could therefore be used as a soil amendment for liming purposes.

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679. Lettuce (*Lactuca sativa* L.) and cabbage (*Brassica oleracea* L. var. *capitata* L.) growth in soil mixed with municipal solid waste compost and paper mill sludge composted with bark.

Brito, L. M.

Acta Horticulturae 563: 131-137. (2001)

NAL Call #: 80 Ac82; ISSN: 0567-7572

Descriptors: application rates/ cabbages/ composts/ dry matter accumulation/ electrical conductivity/ growth/ lettuces/ mortality/ nutrient uptake/ paper mill sludge/ soil amendments/ solid wastes/ Capparales/ death rate

Abstract: Crop responses to soil amended with municipal solid waste compost and paper mill sludge composted with bark was investigated in pot experiments using lettuce (*Lactuca sativa*) cultivars Animo and Jory and summer cabbage (*Brassica oleracea* var. *capitata*) cv. Lima. Dry matter accumulation generally increased with increasing concentrations of composted paper mill sludge. Municipal waste compost severely reduced plant growth compared to composted paper mill sludge, and caused complete crop mortality unless leached beforehand with water. The main cause of death or growth inhibition of experimental plants observed with municipal solid waste compost is likely to be the result of its poor stability and high electrical conductivity. Lettuce dry matter accumulation increased when composted paper mill sludge treatments were amended with ammonium nitrate up to between 0.1 and 0.2 g N l⁻¹ but declined with further amounts. Dry matter accumulation of lettuce and nitrogen accumulation of cabbage could be described as a function of compost nitrogen content and electrical conductivity. Possible methods for improving the characteristics of such composts as substrates for horticultural crops are discussed. Reproduced with permission from the CAB Abstracts database.

680. Management and benefits of pulp and paper mill residuals.

Velema, G.

In: Proceedings of the 2003 TAPPI International Environmental Conference and Exhibit. Portland, OR; pp. 306-316; 2003.

Notes: Conference code: 61670. Sponsors: TAPPI; NCASI; PAPTAC; FSDA.

Descriptors: industrial management/ industrial wastes/ recycling/ soil amendments/ paper and pulp mills/ industrial wastes/ paper mills/ pulp mills/ recycling

Abstract: Domtar Inc. operates a comprehensive land application program for two of its pulp and/or paper mills located in Ontario. Solid organic residues known as Pulp and Paper Mill Biosolids (PPMB) generated by the effluent treatment plants of both mills are used as soil amendments, fertilizer or mulch in agriculture, silviculture and land rehabilitation projects. The 10-year-old program has developed to sustainably recycle 100 percent of PPMB organic type residues that were formerly managed as waste and landfilled. Landfilling and

incineration is still a common management option for most of the Pulp and Paper industry in Canada. The Pulp and Paper Research Institute of Canada determined, from the results of a survey in 1995, that industry generated 7.1 million dry tones of residues; 23% of which were PPMB. An estimated 119,000 dry tones of PPMB were land applied in Canada, representing 7% of the total available. A 2001 follow-up survey indicated that this had increased to where 42% practised some degree of land application. Land application of PPMB is safe, ecologically sustainable, environmentally responsible, agronomically beneficial, and economically sensible. Although the regulatory regimes in Canada at the provincial and federal levels discourage the recycling of "industrial wastes", many opportunities exist for the wise use of these resources through land application, provided programs deal with their communities and publics in an open and proactive manner.

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681. Management and benefits of pulp and paper mill residuals at Domtar Cornwall.

Velema, G.

Pulp and Paper Canada 105(7): 26-30. (2004); ISSN: 03164004 [PPCAA]

Descriptors: agriculture/ fertilizers/ industrial wastes/ land reclamation/ mulch/ organic materials/ silviculture/ soil conditioners/ accident prevention/ ecology/ health care/ industrial management/ land fill/ sustainable development/ biosolids/ biotreatment/ community relations/ corwall mill/ paper and pulp mills/ ecology/ land fill/ paper mills/ pulp mills/ safety

Abstract: Domtar Inc. operates a comprehensive land application program for two of its pulp and/or paper mills located in Ontario. Solid organic residues are used as soil amendments, fertilizer or mulch in agriculture, silviculture and land rehabilitation projects. Land application of PPMB is safe, ecologically sustainable, environmentally responsible, agronomically beneficial, and, economically sensible. Opportunities exist for the wise use of "industrial wastes" as resources through land application, provided programs deal with their communities and publics in an open and proactive manner.

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682. Management of treated pulp and paper mill effluent to achieve zero discharge.

Asghar, M. N.; Khan, S.; and Mushtaq, S.

Journal of environmental management 88(4): 1285-1299. (2008)

NAL Call #: HC75.E5J6; ISSN: 03014797 [JEVMA].

Notes: doi: 10.1016/j.jenvman.2007.07.004.

Descriptors: closed water cycle/ effluent reuse/ groundwater pollution/ irrigation/ paper mill/ soil contamination/ stream flows/ zero discharge/ ground water/ discharge/ effluent/ environmental impact assessment/ environmental monitoring/ groundwater pollution/ irrigation/ pulp and paper industry/ streamflow/ wastewater/ water management/ agricultural land/ consumer attitude/ controlled study/ crop/ effluent/ environmental impact assessment/ irrigation (agriculture)/ paper industry/ pulp mill/ soil pollution/ waste water management/ waste water recycling/ water pollution/ water quality/ water supply/ industrial waste/ paper/ textile industry/ water pollutants, chemical/ animalia

Abstract: Pulp and paper mills are one of the major effluent generating industries in the world. In most cases, mill effluent (treated or raw) is discharged back into a river, creek, stream or other water body; resulting in negative environmental impacts, as well as social concerns, among the downstream users. Pulp and paper mill effluent management, which could result in zero discharge into downstream water bodies, would present the best management option to address socio-environmental concerns. This paper presents such an effort aimed at closing the water cycle by using treated effluent from the mill to irrigate forage and fodder crops for producing animals feed. The treated effluent is delivered from the mill through gravity into a winter storage dam of 490 ML capacity. For irrigation applications on 110 ha of farmland, which is 42% of the total farmland, the water is pumped from the winter storage dam to five individual paddocks with Centre Pivot (CP) irrigators and one rectangular paddock with a Soft Hose Travelling (SHT) irrigator. From October 2001 to June 2006, a total of 2651 mm of wastewater was applied at the farm. The impact assessment results, obtained from field monitoring, investigations and analysis, indicated that the closed water cycle effluent management strategy described had resulted in a lessening of the impact on water resources usually associated with paper mills. However, social attitudes to the use of crops that have been irrigated with recycled waters and the resulting impact on market value of the produce may still be a major consideration. © 2007 Elsevier Ltd. All rights reserved. © 2009 Elsevier B.V. All rights reserved.

683. Microbial biomass C, N, P dynamics in a meadow amended with papermill sludges.

Arfaoui, M. A.; Simard, R. R.; Laverdiere, M. R. ; Chabot, R.; and Antoun, H.

In: 1999 Annual Meeting of the Canadian Society of Soil Science..Charlottetown, Prince Edward Island, Canada.); Vol. 79(4).; pp. 639; 1999.

NAL Call #: 56.8 C162; ISBN: 0008-4271

Descriptors: nutrition/ waste management: sanitation/ soil science/ microorganisms: microorganisms/ humic gleysol/ meadow/ microbial biomass/ nutrient dynamics/ papermill sludge: soil / amendment/ abstracts

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684. Mixed paper mill sludge effects on corn yield, nitrogen efficiency, and soil properties.

N' Dayegamiye, A.

Agronomy Journal 98(6): 1471-1478. (Nov. 2006-Dec. 2006)

NAL Call #: 4 AM34P; ISSN: 0002-1962

Descriptors: Zea mays / corn/ grain yield/ nitrogen/ nutrient uptake/ nutrient use efficiency/ pulp and paper mill effluents/ land application/ plant nutrition/ soil fertility/ field experimentation/ organic fertilizers/ fertilizer rates/ soil aggregates/ diameter/ soil density/ bulk density/ soil physical properties/ soil biological properties/ soil microorganisms/ alkaline phosphatase/ urease/ enzyme activity/ Quebec

Abstract: Large quantities of mixed paper mill sludges (PMS) are applied annually to agricultural soils in North America. However, little information exists in the literature delineating the impact of land application of PMS on crop N

nutrition and soil properties. In a 3-yr field study, (1997-1999), we evaluated PMS effects on corn (*Zea mays* L.) yields and soil property changes. The study included annual and biennial PMS applications of 20, 40, and 60 Mg ha⁻¹ on wet basis, applied alone or in combination with N fertilizer at reduced rates (90 and 135 kg N ha⁻¹ for 40 and 20 Mg PMS ha⁻¹, respectively), complete N fertilizer for corn (180 kg N ha⁻¹) and a control. Plots were split beginning with the second year for annual and biennial PMS and N fertilizer application. Annual or biennial applications of PMS alone resulted in grain yield increase of 1500 to 3000 kg ha⁻¹ as compared to the unfertilized control. The applications of 20 to 40 Mg ha⁻¹ PMS with N fertilizer at reduced rates (135 and 90 kg ha⁻¹ respectively) achieved higher corn yields compared to PMS applied alone. The PMS applications combined with N fertilizer at reduced rates produced highest corn yields, similar to those obtained with complete N fertilization for corn (180 kg N ha⁻¹). Corn apparent N recoveries (ANR) ranged from 17 to 21% in year of application and from 15 to 22% in residual year, depending of PMS rates. Three PMS applications at 40 to 60 Mg ha⁻¹ yr⁻¹ significantly increased the soil C content by 22 and 26%, and by 18 and 22%, compared to the control and N fertilizer, respectively. Those PMS applications also significantly increased the mean-weight diameter (MWD) of aggregates, and reduced soil bulk density as compared to the control and fertilizer alone treatment. The soil microbial biomass C and the alkaline phosphatase and urease activities were also increased in soils that received PMS. Our results suggest that the applications of PMS with low C/N (19-24) benefit corn growth possibly due to a combination of the higher nutrient availability and the improvement of the soil properties. This citation is from AGRICOLA.

685. Mixed papermill residues affect yield, nutritive value and nutrient use of a grass-alfalfa sward.

Arfaoui, M. A.; Simard, R. R.; Belanger, G.; Laverdiere, M. R.; and Chabot, R.

Canadian Journal of Soil Science 81(1): 103-111. (2001)
NAL Call #: 56.8 C162 ; ISSN: 0008-4271

Descriptors: calcium ammonium nitrate/ crop yield/ dry matter/ Gleysols/ grass sward/ lucerne/ nitrate nitrogen/ nitrogen/ nutrient uptake/ nutritive value/ paper mill sludge/ soil types/ alfalfa/ ammonium nitrate/ calcium carbonate/ calcium carbonate/ ammonium nitrate/ CAN/ nitrochalk/ nutritional value/ quality for nutrition

Abstract: Mixed paper mill residues (MPR) can improve soil quality, but their impact on forage yield and quality is not well documented. Three MPR were applied to mixed grass-lucerne (*Medicago sativa*) sward in an experiment conducted at the Université Laval Agronomic Centre located at Sainte-Croix de Lotbinière during 1997 and 1998 at near 100, 200 and 400 kg N ha⁻¹ and were compared to calcic ammonium nitrate (CAN) at 0, 50, 100 and 200 kg N ha⁻¹ on a Bedford clay loam (Humic Gleysol). The MPR and CAN induced a significant linear increase in forage dry matter yield and relative yield. The sward response to MPR addition in 1997 was related to the MPR C:NH₄⁺ ratio. MPR and CAN increased the forage neutral detergent fibre concentration in 1998, but there was no effect in 1997. Nitrogen concentration in forage tissues was increased by MPR and CAN inputs in 1997, but was decreased in 1998.

In all treatments, NO₃⁻ tended to accumulate in forage tissues when the N nutrition index exceeded the optimum level. Forage nutritive value from the MPR was comparable to CAN. The results of this study suggest that MPR can be an efficient N source for grass-lucerne swards on fine-textured soils.

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686. Mixtures of papermill biosolids and pig slurry improve soil quality and growth of hybrid poplar.

Lteif, A.; Whalen, J. K.; Bradley, R. L.; and Camire, C.

Soil Use and Management 23(4): 393-403. (2007)
NAL Call #: S590.S68; ISSN: 0266-0032

Descriptors: application rates/ biological activity in soil/ calcium/ calcium ammonium nitrate/ forest plantations/ Gleysols/ growth/ microbial flora/ nitrate nitrogen/ nitrification/ organic amendments/ organic farming/ organic fertilizers/ paper mill sludge/ phosphorus/ pig slurry/ potassium/ soil fertility/ soil ph/ soil types/ triple superphosphate/ use efficiency/ ammonium nitrate/ calcium carbonate/ calcium carbonate/ ammonium nitrate/ CAN/ eco agriculture/ ecological agriculture/ microbial biomass/ microbial communities/ microflora/ nitrochalk/ organic culture / *Populus balsamifera* subsp *trichocarpa*/ soil quality/ soil respiration

Abstract: Hybrid poplar plantations in Quebec, Canada, are generally established on marginal agricultural lands characterized by low pH and low inherent soil fertility. Here, we tested the hypothesis that two potential organic fertilizer (OF) sources, papermill biosolids (PBs) and liquid pig slurry (LPS), would improve soil quality and the growth performance of hybrid poplars (*Populus trichocarpa* x *Populus deltoides*), especially if applied in mixtures rather than separately. The fertilizer treatments included an unfertilized control, inorganic fertilizer (IF) (calcium ammonium nitrate and triple superphosphate) and OFs (PBs alone, LPS alone and two combinations of PBs and LPS) applied at two rates. Fertilizers were broadcast within 1 m of tree trunks and unincorporated, to prevent damage to tree roots. Hybrid poplar growth was the greatest in plots fertilized with a combination of PBs and LPS, suggesting that the two OFs complemented themselves and/or interacted to improve soil nutritional quality. PBs were the most efficient at raising soil pH, providing plant-available Ca and increasing nitrification rates over the long term, whereas LPS provided more readily available NO₃-N, P and K. Applied together, PBs and LPS interacted to provide more extractable P and mineralizable NH₄-N than when applied separately. OFs increased soil biological activity, notably basal respiration, microbial biomass, metabolic quotient and mineral N production rates. Community-level catabolic profiles of the extractable soil microflora in plots with OFs differed significantly from the control and IF treatments. This implies that surface-applied OFs may induce fundamental changes to the diversity and composition of microbial communities in the underlying rooting zone. Although this study has shown beneficial effects of OF mixtures on soil quality and hybrid poplar growth, further research should focus on their possible environmental impacts.

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687. Modeling aggregate internal pressure evolution following immersion to quantify mechanisms of structural stability.

Zaher, H.; Caron, J.; and Ouaki, B.

Soil Science Society of America Journal 69(1): 1-12. (Jan. 2005-Feb. 2005)

NAL Call #: 56.9 So3; ISSN: 0361-5995

Descriptors: soil aggregates/ aggregate stability/ soil structure/ wetting front/ swelling (materials)/ organic matter/ pulp and paper sludge/ soil amendments/ saturated hydraulic conductivity

Abstract: Identification of the key components controlling aggregate stability is important in soil structure research. The deterioration of soil aggregates during rapid wetting has often been attributed to the swelling and internal pressure buildup resulting from the compression of entrapped air by the advancing wetting front. Organic matter is known to reduce the extent of slaking, but the different modes of action have not yet been quantified. The objective of the study was to use theoretical three-dimensional models to quantify the effect of paper sludge amendment on the key processes controlling internal pressure evolution. A clay loam and a silty-clay loam were incubated for a 2-wk period with different amounts and types of paper sludge. Aggregates were then selected, air dried, and then fixed to a hypodermic needle connected to a pressure transducer, and the whole system was immersed in distilled water while images and pressure evolution were recorded. For both soils, the maximum internal pressure was lower in the sludge-amended aggregates. From the models fitted to the observed data, it appears that the addition of paper sludge resulted in an increase of the potential at the wetting front and a decrease of the near saturated hydraulic conductivity. This result suggests that sludge addition reduces pressure buildup by reducing the rate of water entry, lowering the potential at the wetting front and reducing the hydraulic conductivity of the aggregate.

This citation is from AGRICOLA.

688. Multiple applications of paper mill sludge in an agricultural system: Soil effects.

Zibilske, L. M.; Clapham, W. M.; and Rourke, R. V.
Journal of Environmental Quality 29(6): 1975-1981. (Nov. 2000-Dec. 2000)

NAL Call #: QH540.J6; ISSN: 0047-2425 [JEVQAA]

Descriptors: soil properties/ land application/ agricultural soils/ paper mill sludge

Abstract: Little information exists regarding the effects of field-scale application of paper mill sludge on soil properties. A 5-yr field study determined the long-term effects of land application of paper mill sludge on an agricultural soil. The goal of this study was to determine the responses of soil chemical and physical properties to multiple applications of sludge. Five rates of sludge application were tested, ranging from 0 to 225 Mg ha⁻¹ in multiple applications under three management protocols: applied once, applied in alternate years, or applied annually. Results indicate strong relationships between added sludge C and several soil physical properties. Increases or maintenance of soil C were observed when sludge was applied annually or biennially, but little residual effect of the single application was seen after 5 yr. Significant increases were observed in soil aggregation and moisture holding properties at higher rates of sludge

application and when cumulative C additions reached 225 Mg ha⁻¹ in other sludge application rates. It was concluded that long-term paper mill sludge application can be managed to effect positive changes in soil physical properties that are correlated to soil quality. This citation is from AGRICOLA.

689. Net nitrogen immobilization in soil induced by small additions of energy sources.

Hamner, K and Kirchmann, H

Acta Agriculturae Scandinavica Section B, Soil and Plant Science. 2005; 55(3): 177-185(2005)

NAL Call #: 11 Ac82 ; ISSN: 0906-4710

Descriptors: agricultural land/ agricultural soils/ ammonium/ application rates/ application to land/ biological activity in soil/ carbon/ chemical composition/ energy sources/ Entisols/ glucose/ hemicelluloses/ immobilization/ leaching/ microbial activities/ microbial flora/ nitrate/ nitrogen/ paper mill sludge/ sludges/ soil types/ wood fibres/ dextrose/ farmland/ inorganic nitrogen/ land application/ microbial biomass/ microflora/ soil respiration

Abstract: This study investigated whether small additions to soil of primary paper-mill sludge, a wood fibre residue from paper production (fibre sludge), caused temporary N immobilization and thereby reduced the amount of inorganic nitrogen leached from agricultural land. This was achieved by measuring respiration and immobilization of N in incubation studies at 8 degrees C, with fibre sludge added at rates varying from 63 to 1000 mg C kg⁻¹ soil. Glucose added at rates of 63-250 mg C kg⁻¹ soil was used as a reference. Respiration in soil after glucose addition followed an exponential course with the highest rates on days 2-4. During this period maximum peaks of net N immobilization were measured. Even addition of only 63 mg glucose-C kg⁻¹ soil caused significant immobilization of N in soil. Fibre sludge additions to soil caused lower respiration activities, characterized by two initial peaks followed by somewhat higher respiration rates during the remaining incubation than for glucose. It was likely that hemicellulose, which amounted to 14% of the total C, was the initial available energy source in the sludge as concentrations of water-soluble C were very low. Addition of at least 250 mg C kg⁻¹ soil as fibre sludge was required to cause significant N immobilization in soil corresponding to 5 kg N ha⁻¹. Both nitrate and ammonium were immobilized. Relating maximum N immobilization data during days 2 to 10 to corresponding respiration data for glucose and fibre sludge revealed that microbes utilised similar amounts of C per unit N immobilized. On average, 175.6±74.8 mg CO₂-C were respired to immobilize 1 mg N and the relationship between C respiration and N immobilization was linear (R²=0.984). To make soil application of fibre sludge a realistic counter-measure against N leaching from agricultural soils, pre-treatment is necessary to increase the content of energy readily available to microbes.

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690. Nitrogen mineralization and nitrate leaching of a sandy soil amended with different organic wastes.

Burgos, P.; Madejon, E.; and Cabrera, F.

Waste Management and Research 24(2): 175-182. (2006)

NAL Call #: TD896.W37 ; ISSN: 0734-242X

Descriptors: aerobic conditions/ carbon nitrogen ratio/ composts/ immobilization/ leaching/ mineralization/ moisture content/ nitrate/ nitrate nitrogen/ nitrogen/ organic wastes/ paper mill sludge/ refuse/ sandy soils/ soil amendments/ soil types/ solid wastes/ temperature/ municipal wastes/ trash

Abstract: Organic wastes can be recycled as a source of plant nutrients, enhancing crop production by improving soil quality. However, the study of the dynamic of soil nutrient, especially the N dynamic, after soil application of any organic material is vital for assessing a correct and effective use of the material, minimizing the losses of nitrate in leachates and avoiding the negative environmental effects that it may cause in groundwater. To estimate the effect of three organic materials, a municipal solid waste compost (MWC), a non-composted paper mill sludge (PS), and an agroforest compost (AC) on the N dynamic of a sandy soil two experiments were carried out: an incubation experiment and a column experiment. The incubation experiment was conducted to estimate the N mineralization rate of the different soil-amendment mixtures. The soil was mixed with the organic amendments at a rate equivalent to 50 000 kg ha⁻¹ and incubated during 40 weeks at constant moisture content (70% of its water-holding capacity) and temperature (28 degrees C) under aerobic conditions. Organic amendment-soil samples showed an immobilization of N during the first weeks, which was more noticeable and longer in the case of PS-treated soil compared to the other two amendments due to its high C/N ratio. After this immobilization stage, a positive mineralization was observed for all treatment, especially in MWC treated soil. Contemporaneously a 1-year column (19 cm diameter and 60 cm height) experiment was carried out to estimate the nitrate losses from the soil amended with the same organic materials. Amendments were mixed with the top soil (0-15 cm) at a rate equivalent to 50 000 kg ha⁻¹. The columns were periodically irrigated simulating rainfall in the area of study, receiving in total 415 mm of water, and the water draining was collected during the experimental period and analysed for NO₃-N. At the end of the experimental period NO₃-N content in soil columns at three depths (0-20, 20-35 and 35-50 cm) was determined. The nitrate concentration in drainage water confirmed the results obtained in the incubation experiment: nitrate leaching was higher in soil treated with MWC due to its higher N-mineralization rate. Nevertheless, the nitrate losses represented a low amount compared with the total nitrogen added to soil. No clear signs of water-draining contamination were observed during the first year after the application of AC and PS; however, the nitrate leaching in soil treated with MWC slightly exceeded the limit allowed for the Drinking Water Directive 98/83/CE.

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691. Nitrous oxide release from soils receiving N-rich crop residues and paper mill sludge in eastern Scotland.

Baggs, E. M.; Rees, R. M.; Castle, K.; Scott, A.; Smith, K. A.; and Vinten, A. J. A.

Agriculture, Ecosystems and Environment 90(2): 109-123. (2002)

NAL Call #: S601.A34 ; ISSN: 0167-8809

Descriptors: broccoli / Cambisols/ crop residues/ denitrification/ diurnal variation/ emission/ lettuces/ nitrogen/

nitrous oxide/ organic carbon/ paper mill sludge/ ploughing/ soil amendments/ soil temperature/ soil types/ Britain/ Calabrese/ Capparales/ microbial biomass/ plowing/ United Kingdom

Abstract: Incorporation of crop residues and other organic material to agricultural soils may increase nitrous oxide (N₂O) emissions, depending on the quantity and quality of the incorporated material. The effects of combining materials of contrasting quality on these emissions have still to be investigated. In this paper, the effects of applying paper mill sludge (PMS), incorporating plant residues, and cultivation on emissions of N₂O are reported. Two field experiments were undertaken on Cambisol soils (FAO classification), previously cropped to iceberg lettuce (*Lactuca sativa* var. *saladin*) and calabrese (*Brassica oleracea* italica var. *cymosa*) in Fife, eastern Scotland. Emissions were measured using both automated and manual closed chambers and comparisons were made between these techniques. Nitrous oxide emissions were high after incorporation of PMS; with up to 4.9 kg N₂O-N ha⁻¹ emitted over the first 3 weeks. These increased emissions were probably due to the high input of organic C for denitrification. Emissions from deep ploughed PMS treatments were higher (P<0.05) than from rotary tilled and conventional ploughed treatments. Application of PMS resulted in an increase in microbial biomass C, but not biomass N. Measurements using autochambers recorded higher N₂O emissions than those obtained by less frequent manual measurements, partly due to diurnal variations in N₂O with soil temperature. High Q_{10s} (up to 4.0) for this temperature response were recorded in one period in July. It is recommended that diurnal temperature variations be recorded when sampling from manual closed flux chambers so that corrections can be made for diurnal variation in N₂O.

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692. Nursery crop response to substrates amended with raw paper mill sludge, composted paper mill sludge and composted municipal waste.

Chong, C. and Purvis, P.

Canadian Journal of Plant Science 84(4): 1127-1134. (2004)

NAL Call #: 450 C16; ISSN: 0008-4220

Descriptors: bark/ composting/ composts/ dry matter/ farmyard manure/ growth/ hemp/ nurseries/ paper/ paper mill sludge/ peat/ poultry manure/ refuse/ regression analysis/ sawdust/ substrates/ FYM/ municipal wastes/ Oleales/ poultry litter/ trash

Abstract: Silverleaf dogwood (*Cornus alba* L. 'Argenteo-marginata'), forsythia (*Forsythia* x *intermedia* Zab. 'Lynwood Gold'), and weigela (*Weigela florida* Bunge A.DC. 'Red Prince') were grown in #2 (6-L) containers filled with 100% bark or bark mixed with 20, 40 or 60% by volume each of raw paper mill sludge (RB group), Bio Soil compost containing 100% paper mill sludge (BCB group), Waterdown compost containing 40% paper sludge, 40% chicken manure and 20% sawdust (WCB group), and municipal compost consisting of leaf and yard waste (MCB group). A fifth substrate group (MCH) consisted of 100% hemp chips or hemp chips mixed with the same rates of municipal compost. The containers were trickle-irrigated and fertilized with a controlled-release fertilizer. Regression analysis indicated that growth among the bark-amended

groups was highest for dogwood and forsythia with WCB, increasing dramatically and peaking at about the 40% rate (68 and 94 g plant⁻¹ aboveground dry weight, respectively). Growth of these species was intermediate with MCB and BCB and least with RB, increasing to rates $\geq 50\%$ in these groups. There was no significant response of dogwood to RB. Growth of weigela increased equally with WCB and MCB substrates up to about 40% (117 g plant⁻¹), but was not influenced by varying rates of RB and BCB. With the hemp-amended MCH group, growth of all three species increased to rates $\geq 50\%$ (62, 93, and 116 g plant⁻¹ for dogwood, forsythia and weigela, respectively). Growth of the three species over most rates of all substrate groups was similar to, or exceeded that in 80% bark: 15% peat: 5% topsoil, a proven nursery mix. Aboveground dry weight of all three species was positively correlated with soluble salts concentrations in the substrates sampled at planting and on other sampling dates during the season. Reproduced with permission from the CAB Abstracts database.

693. Nutrient leaching potential following application of papermill lime-sludge to an acidic clay soil.

Vettorazzo, S. C.; Amaral, F. C. S.; and Chitolina, J. C. *Revista Brasileira de Ciencia do Solo* 25(3): 755-763. (2001)

NAL Call #: S590 .R44 ; ISSN: 0100-0683

Descriptors: acid soils/ application rates/ application to land/ biomass production/ chemical composition / clay soils/ crop yield/ growth/ leachates/ leaching/ lime/ mineral nutrition/ paper mill sludge/ soil composition/ soil fertility/ Eucalyptus grandis x Eucalyptus urophylla/ land application
Abstract: This experiment was carried out under greenhouse conditions with soil pots during 210 days, to evaluate the effect of calcitic paper mill lime-sludge application (at the rates 0, 773, 1,547, and 2,320 mg kg⁻¹ or respective equivalents to control, 2, 4, and 6 t ha⁻¹), on chemical composition of soil leachate and its effects on eucalypt (Eucalyptus grandis x E. urophylla) growth and yield. Highest soil leachate pH, SO₄, and Na concentrations occurred in the 4 and 6 t ha⁻¹ treatments. Soil leachate nitrate concentrations decreased with increasing lime-sludge rate. Soil leachate phosphate remained low (below the detection limit) in all treatments until 120 days, while the concentration increased in the lime-sludge treatments at 210 days (last sampling) in about 600 mg litre⁻¹. Lime-sludge decreased leachate Mg concentration, but had no significant effect among rates. Soil leachate Ca, K, B, Cu, Fe, and Zn did not change significantly for any lime-sludge application rates. The maximum NO₃, Ca, Mg, K, and Na concentrations in the soil leachate occurred at 60 days after lime-sludge application (leaching equivalent to 1 pore volume), but for pH and SO₄, the maximum occurred at 210 days (leaching equivalent to 4 pore volumes). Lime-sludge application decreased the concentration of exchangeable Al in the soil. Plant diameter growth and dry matter yield were increased with increasing lime-sludge rate. Beneficial effects on mineral nutrition (P, K, Ca, B, and Zn) of eucalyptus were also obtained by the application of 4 and 6 t ha⁻¹ of lime-sludge.

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694. Optimization of reed residue substrate formula for tomato plug seedling production.

Li QianSheng; Bu ChongXing; Ye Jun; Guo ShiRong; and Li ShiJun

Acta Agriculturae Shanghai 19(4): 73-75. (2003); ISSN: 1000-3924

Descriptors: growing media/ optimization/ paper mill sludge/ plant residues/ porosity/ seedling growth/ seedlings/ substrates/ tomatoes/ waste utilization/ water holding capacity/ water uptake/ potting composts/ rooting media
Abstract: Reed residue substrate, a new local organic substrate made from solid wastes of paper mill, was developed and extended in East China as peat alternative for soilless culture and nursery production. Ten formulas based on composted reed residue were used in tomato plug seedling production and Cornell complex was used as the control. Results showed that the substrate consisting of 75% composted reed residue and 25% vermiculite was the best. This substrate had a 21% aeration porosity, 57% water holding capacity, and high water absorbing and retaining capacity which enabled a vigorous growth of the plants.

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695. Optimizing composting of paper mill sludge and hardwood sawdust under optimum conditions.

Champagne, P.; Marche, T.; Diné, H.; Schnitzer, M.; and Paré, T.

In: Joint 2002 CSCE/ASCE International Conference on Environmental Engineering: An International Perspective on Environmental Engineering.

Niagara Falls, Ont.; pp. 931-942; 2002.

Notes: Conference code: 65425. Sponsors: Canadian Society for Civil Engineering; ASCE, Environment and Water Resources Institute.; ISBN: 088955532X

Descriptors: bio-available C/ N/ biostabilization/ composting/ paper mill sludge/ sawdust/ composting/ concentration (process)/ hardwoods/ optimization/ paper and pulp mills/ recycling/ sawdust/ spectroscopic analysis/ bio-available c/ n/ biostabilization/ composted materials/ paper mill sludge/ sludge disposal/ composting/ hardwoods/ optimization/ paper mills/ pulp mills/ recycling/ saw dust/ sludge disposal

Abstract: Recycling of paper mill sludge by means of composting is becoming an acceptable practice for converting organic residues into useful soil amendments, while eliminating negative environmental impacts. The main chemical structures of paper mill sludge composted materials produced by industrial-scale and pilot-scale in-vessel processes were investigated in order to better understand the chemical changes occurring during composting. Chemical and spectroscopic methods were used to characterize the composition of the paper mill sludge composted materials. The spectroscopic data revealed that the major components identified in the paper mill sludge were lipids, sterols, lignins, nitrogen-compounds, and carbohydrates. In the pilot-scale process, organic matter loss was approximately 50% higher than in the industrial-scale process. By the end of composting, the concentrations of nitrogen-compounds remained relatively unchanged in the pilot-scale process, whereas in the industrial-scale process, nitrogen-compounds continually

decreased indicating that the biochemical transformations of organic matter were not completed. Thus, composting of paper mill sludge can be successfully achieved if key operating parameters are optimized to reduce losses of nitrogen.

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696. Organic soil amendments: Impacts on snap bean common root rot (*Aphanomyces euteiches*) and soil quality.

Céspedes Leon, M. C.; Stone, A.; and Dick, R. P. *Applied Soil Ecology* 31(3): 199-210. (2006)

NAL Call #: QH541.5.S6 A67; ISSN: 0929-1393

Descriptors: aggregates/ application rates/ arylsulfatase/ beta glucosidase/ bioassays/ biological indicators/ carbon/ composts/ enzyme activity/ fungal diseases/ hydrolysis/ incidence/ microbial flora/ organic amendments/ paper mill sludge/ plant disease control/ plant diseases/ plant pathogenic fungi/ plant pathogens/ root rots/ sandy loam soils/ soil amendments/ soil enzymes/ soil fertility/ soil properties/ soil types/ suppression/ temporal variation/ arylsulphatase/ beans *Phaseolus*/ green bean/ microbial biomass/ microflora/ *Peronosporomycetes*/ phytopathogens/ *Saprolegniaceae*/ snap bean/ soil quality/ *Straminipila*/ United States of America

Abstract: Common root rot (causal agent *Aphanomyces euteiches*) [*Aphanomyces euteiches*] is a major disease of commercially grown snap bean (*Phaseolus vulgaris* L.). Organic amendments hold potential to suppress plant diseases, which may be due to changes in soil biology and other soil properties. The objective of this study was to determine the potential of paper-mill residual by-products to suppress common root rot of snap bean in relation to soil properties. The study was done on soil (Plainfield sandy loam, Hancock, WI) from a field trial comparing annual applications of fresh paper-mill residuals (0, 22 or 33 dry Mg ha⁻¹) or composted paper-mill residuals (0, 38 or 78 dry Mg ha⁻¹). Soil was removed from each treatment that had been in place 3 years in April 2001 (1 year after last amendment) and on September 2001 (4 months after last amendment) and brought to the laboratory. Soils were incubated at field moisture content (25 degrees C) and periodically bioassayed with bean seedlings (9, 44, 84, 106, 137, 225 or 270 days after removal from the field) for snap bean root rot. Soils were sampled on the same day as the root rot bioassay and assayed for beta -glucosidase, arylsulfatase and fluorescein diacetate hydrolysis activities (FDA), microbial biomass-C (MB_c) (by chloroform fumigation), water stable aggregation, and total C. There were large differences in snap bean root rot incidence between the field amendment treatments. The unamended field soil had high levels of disease incidence throughout the experiment but disease incidence tended to decrease over time in amended soils. The disease was suppressed by both fresh and composted paper-mill residuals, but the composted residuals at high rates had the lowest disease incidence (<40%) and produced healthiest plants. Root rot severity was strongly negatively correlated with total C (0.001<=p) and arylsulfatase activity (0.001<=p). beta - Glucosidase activity was negatively correlated (0.05<=p) with disease severity while soil MB_c showed inconsistent negative correlations with disease severity over the incubation sampling periods. Arylsulfatase activity was the best indicator for reflecting disease suppression. The amendments improved soil quality, which was

exemplified by improved aggregation.

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697. Organic wastes for improving soil physical properties and enhancing plant growth in container substrates.

Nkongolo, N. V.; Caron, J.; Gauthier, F.; and Yamada, M. *Journal of Crop Production* 3(1): 97-112. (2000); ISSN: 1092-678X

Descriptors: growing media/ growth/ ornamental plants/ paper mill sludge/ peat/ perlite/ porosity/ pot plants/ saturated hydraulic conductivity/ sewage sludge/ soil physical properties/ ornamentals/ physical properties of soil/ potting composts/ rooting media

Abstract: Increasing rates (5, 10, 25 and 40% v/v) of 6 sources of organic wastes were substituted for peat to assess changes in the physical properties of peat-perlite substrates and investigate the relationship between plant response and these properties. Wastes were either fresh or composted bio-filter sludge (FBF and CBF), sewage sludge (FSS and CSS), and de-inked paper sludge (FDP and CDP). Geranium plants (*Pelargonium x hortorum* cv. Orbit Hot Pink) were grown in the substrates. Growing media saturated hydraulic conductivity (K_s), air-filled porosity (f_a), pore tortuosity (τ), and relative gas diffusivity (D_s/D_o) all increased linearly as the rate of organic wastes increased. Geranium plant height (PHT), shoot dry mass (SDM) and root dry mass (RDM) were either linearly or quadratically decreased as the amount of waste increased in the substrates. During both growing seasons, geranium SDM and RDM were either linearly or quadratically correlated with D_s/D_o and τ . Organic waste types and their rate of application strongly affected the aeration status of the substrates. D_s/D_o and τ better expressed the relationship between plant growth and the physical conditions of the root zone.

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698. Outlook for the production of organic fertilizers from pulp and paper industrial waste.

Sidorenko, O. D.

Agrokhimiya 6: 64-65. (2003); ISSN: 0002-1881

Descriptors: animal manures/ cattle dung/ cellulose/ cellulosic wastes/ fermentation/ fertilizers/ industrial wastes/ organic fertilizers/ paper/ paper mill sludge/ pulp and paper industry/ wastes/ paper industry

Abstract: Methods of processing paper and cellulose waste for use as fertilizers are briefly described. They include fermentation with the aid of bird droppings and cattle manure.

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699. Paper mill residuals and compost effects on particulate organic matter and related soil functions in a sandy soil.

Newman, C. M.; Rotenberg, D.; and Cooperband, L. R.

Soil Science 170(10): 788-801. (Oct. 2005)

NAL Call #: 56.8 So3; ISSN: 0038-075X

Descriptors: pulp and paper sludge/ pulp and paper industry/ solid wastes/ composts/ soil amendments/ soil organic matter/ application rate/ carbon/ nitrate nitrogen/ ammonium nitrogen/ sandy soils / soil fertility/ nitrogen/

crop production/ crop rotation/ *Solanum tuberosum*/ potatoes/ *Phaseolus vulgaris*/ *Cucumis sativus*/ cucumbers/ paper mill residuals/ particulate organic matter
This citation is from AGRICOLA.

700. Paper mill residuals and compost effects on soil carbon and physical properties.

Foley, B. J. and Cooperband, L. R.

Journal of Environmental Quality 31(6): 2086-2095. (2002)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: available water/ carbon/ composting/ composts/ crop production/ Entisols/ irrigation/ irrigation requirements/ irrigation water/ paper mill sludge/ plant water relations/ potatoes/ soil amendments/ soil organic matter/ soil physical properties/ soil types/ soil water content/ waste management/ waste utilization/ water holding capacity/ organic matter in soil/ physical properties of soil/ United States of America/ watering

Abstract: Use of organic byproducts as soil amendments in agricultural production exemplifies a strategy for converting wastes to resources. The overall objective of this research was to evaluate the short- and intermediate-term effects of repeatedly amending sandy soil (Typic Udipsamment) with paper mill residuals (PMR) and composted PMR in a vegetable rotation in Wisconsin's Central Sands (Wisconsin, USA). Specifically, we investigated the effects of PMR and composted PMR on total soil C and related these to changes in water-holding capacity and plant-available water (PAW). Amendment effects on irrigation requirements were estimated with a simple soil water balance model. The experimental design was replicated five times as a randomized complete block with four organic amendments: raw PMR, PMR composted alone, PMR composted with bark (PMRB), and peat applied at two rates and a nonamended control. All amended treatments significantly increased total soil C relative to the nonamended control following applications in 1998 and 1999. One year following the second serial amendment, all PMR treatments increased PAW by 5 to 45% relative to the control. There was a significant positive linear relationship between total soil C and PAW. All amended treatments reduced the average amount of irrigation water required for potato production by 4 to 30% and the number of irrigation events by 10 to 90%. There was a clear trend of greater reduction in irrigation requirements with more carbon added. The cumulative effects of repeated additions of PMRB suggest that certain composts might sustain elevated PAW and reduce irrigation requirements beyond one year.

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701. Paper mill sludge as a soil amendment: The performance of field beans on a site restored with Gault Clay.

Sellers, G. and Cook, H. F.

In: Land reclamation: extending the boundaries. Proceedings of the 7th International Conference of the International Affiliation of Land Reclamationists. Runcorn, UK.; 193 -200; 2003.

Descriptors: arable farming/ clay soils/ crop yield/ growth/ inoculation/ landfills/ nitrogen/ pulp mill effluent/ reclamation/ soil amendments/ soil organic matter/ soil

types/ waste utilization/ Britain/ green bean/ kraft mill effluent/ organic matter in soil/ snap bean/ United Kingdom
Abstract: Results are presented from a field trial investigating the use of Gault Clay and potentially soil forming materials in the restoration of a Landfill site at Small Dole, West Sussex, UK to arable agriculture. Tertiary paper mill sludge was investigated as a substrate amendment, with field beans as the crop. After one year the paper mill sludge had improved the organic content of both substrates however, the sludge seemed to sequester N from the substrates reducing yield substantially on the Gault Clay. Furthermore, it contained no other mineral nutrients, which may have exacerbated the P deficiency in the Gault Clay. Also, Gault Clay proved difficult to cultivate in wet autumn conditions. Crop performance was superior on the soil forming material probably because it did not stay waterlogged for so long and the beans became inoculated with *Rhizobium* bacteria so lack of N wasn't such a factor compared to the Gault Clay.

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702. Paper mill sludge composting and compost utilization.

Evanylo, G. K. and Daniels, W. L.

Compost Science and Utilization 72(2): 30-39. (1999)

NAL Call #: TD796.5.C58 ; ISSN: 1065-657X

Descriptors: chemical properties/ composting/ composts/ dry matter/ growing media/ growth/ nutrients/ organic wastes/ paper mill sludge/ radishes/ sludges/ utilization/ Capparales/ green bean/ potting composts/ rooting media/ snap bean/ United States of America

Abstract: The potential for composting combined primary and secondary dewatered paper mill sludge (PMS) was assessed and the suitability of the finished product as a potting soil substitute was evaluated. Composting treatments were: (1) PMS with no supplemental N (control), (2) PMS + 15 kg N/t PMS (dry weight), and (3) PMS + 30 kg N/t PMS (dry weight). Composting was conducted for 129 days and treatment effects were evaluated by windrow temperature trends. A container plant growth study employing various particle size fractions and proportions of the control PMS compost and a commercial potting medium (Promixtm) was conducted in a greenhouse to assess the capability of the compost to support growth of radish (*Raphanus sativus*), snap bean (*Phaseolus vulgaris*), marigold (*Tagetes erecta*), and green pepper (*Capsicum* sp.). Windrow temperatures were lower with no supplemental N than with the N additions during the initial three weeks and were higher with increasing N rate during the last month of composting, which indicated that the unamended sludge may have been N-limited for maximum biological activity. Reduced temperatures in the high N treatments during the midpoint of the composting process may have been induced by ammonia toxicity. However, cured compost chemical properties and stability were not influenced by treatment and were indicative of good quality compost. The lower amount of plant-available water and greater amounts of plant-available nutrients supplied by the compost than the commercial potting medium resulted in less dry matter produced by all plants except green pepper, whose higher nutrient needs were supplied better by the compost than the commercial potting medium alone.

Therefore, the paper mill sludge compost may best be used as an organic fertilizer, soil amendment, or supplemental nutrient source for potting media, rather than as a potting medium alone.

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703. Paper mill sludge: Heedstock for tomorrow.

Glenn, J.

Progress in Paper Recycling 7(3): 54-59. (1998); ISSN: 10611452 [00297].

Notes: Chapter Number: Appleton, WI, United States.

Descriptors: agriculture/ composting/ land reclamation/ paper and pulp mills/ recycling/ paper mill sludge/ paper mill wastes/ sludge disposal

Abstract: The paper deals with new trends in the disposal and recycling of paper mill sludge. Today the situation with paper mill sludge recycling is changed and ever increasing amount of it is either put back into the production of paper or otherwise being utilized. It is noted that sludges from paper mills which typically have excellent moisture holding properties and also are a significant source of organic matter are well suited for use in both land reclamation and agriculture by means of composting and other operations. © 2009 Elsevier B.V. All rights reserved.

704. Paper mill sludge-soil mixture: Kinetic and thermodynamic tests of cadmium and lead sorption capability.

Battaglia, A.; Calace, N.; Nardi, E.; Petronio, B. M.; and Pietroletti, M.

Microchemical Journal 75(2): 97-102. (2003); ISSN: 0026265X [MICJA].

Notes: doi: 10.1016/S0026-265X(03)00074-2.

Descriptors: cadmium/ lead/ paper mill sludge/ soil sorption/ aluminum silicate/ cadmium/ carbonic acid derivative/ cellulose/ inorganic compound/ lead/ lignin/ organic compound/ tannin/ chemical interaction/ chemical modification/ heavy metal removal/ paper industry/ sludge/ soil/ thermodynamics

Abstract: Paper mill sludge (characterized by 29.0% of organic substances such as cellulose, lignin and tannins and 71.0% of inorganic substances such as kaolinite and carbonates) was studied in a mixture with soil in order to evaluate its effects on soil capability for retaining heavy metals. Attention was focused on cadmium and lead sorption and two parameters were investigated, the contact time of paper mill sludge-soil mixture and the paper mill sludge-soil ratio in the mixture. Results showed that paper mill sludge and soil interact to form 'new' sorbing sites. Taking into account sorption results of lead, the retention of which by soil is substantially increased by sludge addition, can highlight this modification. Also, the amount of sorbed cadmium was increased by sludge addition. © 2003 Elsevier Science B.V. All rights reserved. © 2009 Elsevier B.V. All rights reserved.

705. Paper mill sludges (biosolids) applications in agriculture: Agronomic and environmental impacts.

N'Dayegamiye, A.; Huard, S.; and Thibault, Y.

In: International Environmental Conference.

Montreal, QC; pp. 651-656; 2002.

Notes: Conference code: 61664

Sponsors: TAPPI; NCASI; PAPTAC; FSDA.

Descriptors: agronomy / bacteria/ biomass/ crops/ effluents/ environmental impact/ enzymes/ fertilizers/ biosolids/ paper and pulp mills/ agronomy/ bacteria/ biomass/ farm crops/ fertilizers/ paper mills/ pollution/ sludge

Abstract: Environmental technologies in paper industry are recognized as important tools in water pollution control and generate high quantities of paper mill sludges (PMS). Large PMS volumes has been used more and more in agriculture for almost five years in the province of Québec, reducing landfilling of these organic materials. In the present study, the agronomic potential and environmental impacts of PMS have been evaluated since 1997 in field experiments in Central Québec on corn, soya and barley crops. Paper mill sludges were applied at rates varying from 20 to 60 t/ha on wet basis, and compared to mineral fertilizer treatments and to a control without any fertilizer and PMS. Results indicated that PMS applied alone significantly increased corn and barley yields, compared to the control treatment. Lower effects were observed on soya bean. Corn and barley highest yields were obtained when PMS were combined with reduced fertilizer rates (50% to 75% NPKMg) leading to higher yields than those obtained with a complete fertilizer application (100% NPKMg). PMS effects on corn and barley yields were mainly due to their high nutrient contents and efficiency and also to their significant effect on soil properties. PMS significantly increased soil microbial biomass, microbial respiration (CO₂), nitrogen mineralization (NO₃) as well as phosphatase and urease activities. PMS applications also increased soil organic matter content and earthworm abundance (data not presented). Results also indicated that three successive PMS applications did not increase soil metal content (Ni, Cr, Co, Cu, Cd and Pb) in the 0-40 cm soil layer, as a result of their low contents in those constituents. Results on E.coli and coliforms also showed lower populations in soil treated with PMS, compared to the control and mineral fertilizer treatments. From this point of view, PMS could be considered safe for use in agriculture when they meet environmental standards. Due to their high nutrient and organic matter contents, PMS are recommended as fertilizers and organic amendments for a sustainable agriculture.

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706. Paper mill waste mixed with compost and other ingredients as container nursery substrates.

Chong, C.

Compost Science and Utilization 11(1): 16-26. (2003)

NAL Call #: TD796.5.C58 ; ISSN: 1065-657X

Descriptors: bulk density/ composting/ composts/ growth/ paper mill sludge/ porosity/ Oleales

Abstract: Growth performance of container-grown dogwood (Cornus alba L. 'Sibirica'), forsythia (Forsythia x intermedia Zab 'Lynwood'), ninebark (Physocarpus opulifolius L.), and weigela (Weigela florida (Bunge) A. DC. 'Variegata Nana') were evaluated in 20 waste-derived substrates classified into five groups. Each group had 0, 20, 40 or 60% (by volume) of paper mill biosolids in binary mixtures with bark (PB group), tertiary mixtures with topsoil and sand (PTS group), and quaternary mixtures with bark, topsoil and sand (PBTS group). There were also similar binary and quaternary mixtures with compost instead of bark (PC and PCTS groups, respectively). With few exceptions, top dry weights of all four species increased

(linear or curvilinear responses) with increasing rate of biosolids, and were higher in the compost-amended PC and PCTS (forsythia, 72-99 g/plant, range over all rates of biosolids; ninebark, 97-116; dogwood, 45-60; and weigela, 18-25) than in bark-amended PB and PBTS (forsythia, 26-71; ninebark, 32-80; dogwood, 33-56; and weigela, 7.7-18) substrates. Top dry weights in a control nursery mix (80:15:5 by vol bark:peat:topsoil) used by nurseries were: forsythia, 70; ninebark, 110; dogwood, 51; and weigela, 48. While none of the weigela plants attained size comparable to that of the control, top dry weights of other species reached or exceeded their control counterparts in PC and PCTS substrates over most or all rates of biosolids (all species); in PB and PBTS with 40-60% of biosolids (forsythia and dogwood); and in PTS with the highest rate of biosolids (forsythia, 91; and ninebark, 140). Higher retention of nutrients in the substrates and/or more favorable bulk densities and air-filled porosities, primarily due to the biosolids, contributed to increased growth and/or foliar nutrient status of the plants. Reproduced with permission from the CAB Abstracts database.

707. Paper pulp as an amendment to a tropical acid soil: Effects on growth of rye grass.

Nkana, J. C. V.; Tack, F. M. G.; and Verloo, M. G. *Communications in Soil Science and Plant Analysis* 29(9/10): 1329-1340. (1998)
 NAL Call #: S590.C63; ISSN: 0010-3624
Descriptors: acid soils/ liming materials/ paper mill sludge/ soil amendments/ soil pH/ ultisols
Abstract: Paper pulp was evaluated, with reference to lime, as a soil amendment to a tropical acid soil (typic Kandiudult). Ryegrass (*Lolium perenne*) was grown under greenhouse conditions. Amendments were applied at rates to attain target pH values of 5.5, 6.0, and 6.5. Paper pulp and lime were equally effective in increasing dry matter production. Similar to lime, paper pulp provided high calcium (Ca) inputs and alleviated aluminum (Al) and manganese (Mn) toxicity. It is concluded that paper pulp can be applied to a tropical acid soil as a lime substitute. Reproduced with permission from the CAB Abstracts database.

708. Paper sludge as a soil amendment for production of corn.

O' Brien, T. A.; Herbert, S. J.; and Barker, A. V. *Communications in Soil Science and Plant Analysis* 34(15-16): 2229-2241. (Sept. 2003)
 NAL Call #: S590.C63; ISSN: 0010-3624
Descriptors: *Zea mays* / corn/ soil amendments/ pulp and paper industry/ industrial wastes/ grain yield/ fertilizer application/ nitrogen fertilizers/ nutrient uptake/ nutrient content/ soil fertility/ plant growth/ dry matter accumulation/ ammonium compound
Abstract: To evaluate paper sludge as a soil amendment for the production of corn (*Zea mays indentata* Bailey 'Pioneer 35N05'), sludge was added to field plots (0 to 448 Mg wet mass ha⁻¹ in 112 Mg units) in May 1998 and was incorporated into the top 15-cm of soil. No sludge was applied in the second year of cropping (1999). In 1998 and 1999, nitrogen (N) was added at 200 or 400 kg ha⁻¹ as ammonium nitrate. Grain or stover yields in 1998 or 1999 were not affected by the addition of paper sludge. Grain yields did not differ between years, but stover production

was greater in 1998 than in 1999. Grain analysis showed an increase in N, phosphorus (P), potassium (K), magnesium (Mg), zinc (Zn), manganese (Mn), and boron (B) concentrations in the year after application of sludge. Also, stover concentrations of copper (Cu) and B were greater in the second growing season than in the first year. Soil analysis showed a decrease in nitrate and calcium (Ca) concentrations with addition paper sludge in 1998. In 1999, nitrate and Ca concentrations did not vary with addition of paper sludge. Soil cation exchange capacity was greater in 1999 than in 1998, with the base saturation being dominated by Ca. Soil pH was 7.0 in 1998 and 7.2 in 1999. Adding paper sludge did not increase soil organic matter, which averaged 2.5%. Results from this study indicated that additions of paper sludge to soil added some nutrients to the crop and did not suppress corn yields. This citation is from AGRICOLA.

709. Paper sludges as soil conditioners.

Norrie, J. and Fierro, A.
Handbook of Soil Conditioners: Substances that Enhance the Physical Properties of Soil: 97-118. (1998)
 NAL Call #: S661.7.H35 1998
Descriptors: amendments/ paper mill sludge/ properties/ sludges / soil conditioners
Abstract: The use of paper mill sludges as soil conditioners and amendments for agricultural, horticultural and silvicultural applications is reviewed. Pulping and bleaching processes and sludge production are described. Current sludge production and disposal methods in paper manufacture are outlined. The characteristics of paper mill sludge are described: physical properties, pH, heavy metals and organic compounds, decay patterns, nitrogen availability, availability of other plant nutrients, salinity and sodicity. Plant responses to paper sludge and other lignocellulosic amendments are reviewed. Reproduced with permission from the CAB Abstracts database.

710. Papermill biosolid and hog manure compost affect short-term biological activity and crop yield of a sandy soil.

Lalande, R.; Gagnon, B.; and Simard, R. R.
Canadian Journal of Soil Science 83(4): 353-362. (2003)
 NAL Call #: 56.8 C162; ISSN: 0008-4271
Descriptors: acid phosphatase/ beta galactosidase/ beta glucosidase/ biological activity in soil/ carbon / composts/ crop yield/ enzyme activity/ fertilizers/ fluorescein/ microbial flora/ mineralization/ nutrient uptake/ paper mill sludge/ pig manure/ Podzols/ potatoes/ sandy soils/ soil enzymes/ soil types/ urease/ wheat/ acid phosphomonoesterase/ microbial biomass/ microflora
Abstract: Soils used for intensive vegetable production often become depleted in their organic matter content, and consequently low in their microbial activity. Papermill sludge compost may be an efficient way to improve the biological activity of these soils. An experiment was initiated to determine the effects of a co-composted papermill sludge and hog manure (PHC), applied alone or in combination with mineral fertilizers (MF), on several biochemical properties and crop yield of a Bevin loamy sand (Orthic Humo-Ferric Podzol) located at Saint-Ubalde, province of Quebec, Canada. The PHC was applied in the spring of 1997 at rates of 0, 11.5, 23 and 34.5 Mg dry weight ha⁻¹, with and without MF equivalent to 150 N-200

P₂O₅-200 K₂O kg ha⁻¹. Potatoes (*Solanum tuberosum* L.) were planted the first year and the residual effect of PHC was evaluated on a spring wheat (*Triticum aestivum* L.) crop in 1998. Enzymatic activity of beta -glucosidase, beta -galactosidase, acid phosphatase, urease and fluorescein diacetate hydrolysis, microbial biomass C (MBC) and CO₂-C release in incubation were measured throughout both growing seasons. Application of 11.5 Mg ha⁻¹ of PHC resulted in the highest enzymatic activities and MBC, representing a mean increase of respectively 30 and 55% over the control. Addition of MF to PHC resulted in a greater increase in enzyme activities (12-18%) than PHC alone but had little effect on MBC. Generally, enzyme activities and MBC decreased in the second season. The carbon mineralization potential was low, indicating that the composted material was relatively stable. The addition of 11.5 Mg PHC ha⁻¹ produced the highest marketable potato tuber yield with (34 Mg ha⁻¹) or without (27 Mg ha⁻¹) fertilizer supplement, whereas the highest wheat grain yield was obtained with the 23 Mg PHC ha⁻¹ level in the following season. When PHC was added at 11.5 Mg ha⁻¹, it markedly improved soil biochemical properties and potato crop yield whereas the 34.5 Mg ha⁻¹ level was excessive. Reproduced with permission from the CAB Abstracts database.

711. Papermill biosolids effect on soil physical and chemical properties.

Price, G. W. and Voroney, R. P.

Journal of Environmental Quality 36(6): 1704-1714. (2007)
NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: aggregates/ agricultural soils/ application rates/ bioavailability/ bulk density/ carbon/ carbon nitrogen ratio/ electrical conductivity/ heavy metals/ hydraulic conductivity/ infiltration/ organic amendments/ paper mill sludge/ soil chemical properties/ soil pH/ soil physical properties/ soil structure/ soil types/ soil water content/ soybeans/ waste utilization/ chemical properties of soil/ physical properties of soil/ soybeans

Abstract: Papermill biosolids (PB) can provide multiple benefits to the soil system. The purpose of this study was to quantify the effects of a high C/N ratio (C/N=100) de-inked PB on soil physical and chemical properties, including soil bulk density, infiltration rates, wet aggregate stability, total soil carbon, and heavy metal concentrations. Four rates of PB (0, 50, 100, and 150 Mg ha⁻¹) were applied annually, for up to 3 yr, on four agricultural soils in Ontario, Canada. Decreases in soil bulk density between 0.27 and 0.35 g cm⁻³, relative to the nonamended treatment, were observed in soils receiving PB treatments over 3 yr. Total soil carbon increased within 1 yr on PB-amended soils planted to soybeans but not on soils planted to corn. Hydraulic conductivities (K_s) were greater in all soils receiving PB amendments relative to the nonamended treatment throughout the study. Other properties measured, such as pH and electrical conductivity, were relatively unchanged after 2 yr of PB applications. While some increases in heavy metal accumulation occurred, there were no clear trends observed at any of the sites related to PB rates. The results of this study provide support to the idea that annual applications of PB can add significantly to the stability of soil structure.

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712. Pelletized chicken litter as a nutrient source for pine establishment in the Georgia coastal plain.

Bush, P B; Merka, W C; and Morris, L A, SRS 20 USDA Forest Service, 1998. 427-432.

Descriptors: costs/ forest plantations/ forest soils/ increment/ paper mill sludge/ phosphorus fertilizers/ poultry manure/ soil amendments/ sulfate pulping/ costings/ kraft process/ kraft pulping/ phosphate fertilizers/ poultry litter/ sulphate pulping/ United States of America

Abstract: The chicken litter was evaluated as a potential phosphorus source for loblolly pine (*Pinus taeda*). Additions of primary sludge from a kraft paper mill stabilized the poultry manure with a high carbon:nitrogen ratio; such mixtures have potential as slow-release nutrient sources. Litter application cost \$9.25/acre vs \$29/acre for diammonium phosphate.

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713. Physical properties of paper sludge-amended media used for evergreen shrub production.

Tripepi, Robert R. and George, Mary W.

In: 98th Annual International Conference of the American Society for Horticultural Science. Sacramento, California, USA.; Vol. 36(3); pp. 499; 2001.

NAL Call #: SB1.H6

Descriptors: horticulture: agriculture/ waste management: sanitation/ coniferopsida: gymnosperms, plants, spermatophytes, vascular plants/ ericaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ rosaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ de-inked paper sludge container media: equipment, ornamental culture/ evergreen shrub production/ meeting abstract/ meeting poster

Abstract: De-inked paper sludge from a newsprint mill was evaluated as a substitute for softwood bark in container media. Rooted cuttings of 'Youngstown' juniper (*Juniperus horizontalis*), Fraser photinia (*Photinia x fraseri*), and 'PJM' rhododendron (*Rhododendron*) were planted in 3-L plastic pots that contained potting media amended with 0%, 20%, 40%, 60%, 80%, or 90% paper sludge and 80%, 60%, 40%, 20%, 0%, or 0% bark, respectively, (by volume). All mixes contained 10% sand and 10% peat moss, except for the 90% mix, which lacked peat moss. Initial bulk density, aeration, water-holding capacity, and total porosity were measured for all media. Final aeration, water-holding capacity, and total porosity were also measured after plants grew in the media for 19 weeks. The heights of the potting mix columns in 16 randomly selected pots for each medium were measured during the second and nineteenth weeks to determine if the volume of the growth medium had changed. The mix made with 90% paper sludge was approx 23% lighter than the control medium that contained 80% bark (control). Initial aeration, water-holding capacity, and total porosity of paper sludge-amended mixes were significantly higher than those of the control, and aeration of the 90% sludge mix was over 2.5-fold higher than that of the control mix. Potting mixes made with 60% or more paper sludge shrunk by 5% or more in volume during the experiment. In fact, the volume of the 90% sludge mix shrunk by almost 13% during the 17-week measurement period. This study demonstrated that paper sludge-amended media were light in weight and well aerated, but their volume also shrunk in proportion to the amount paper used in the mix.

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714. Physicochemical characteristics of lime sludge waste of paper mill and its impact on growth and production of rice.

Medhi, U. J.; Talukdar, A. K.; and Deka, S.

Journal of Industrial Pollution Control 21(1): 51-58. (2005); ISSN: 09702083 [JIPCE]

Descriptors: growth/ impact/ lime sludge/ paper mill/ rice/ yield / crop production/ physicochemical property/ pulp and paper industry/ rice/ sludge

Abstract: The Nagaon paper mill generates about 448 tones (NEERI, 1990) of lime sludge per day as solid waste. The generated lime sludge has been disposed to a nearby low-lying area of the paper mill. The lime sludge contains huge amount of Calcium Carbonate. Since the agricultural soil of Assam is generally acidic in nature, so liming is necessary to maintain the soil pH. Instead of marketed lime, lime sludge waste of paper mill can also be used in the agricultural soil and soil can profitably be used for crop production. Keeping this view in mind the present investigation was carried out to study the effect of lime sludge on soil quality and production of rice. The physicochemical properties of the lime sludge waste have been analysed. It is shown high in alkalinity (pH 10.35), water holding capacity (70.4%), percentage of calcium carbonate (65.62), sodium (211 ppm), potassium (161 ppm), calcium (7433 ppm). Results of pot experiment on growth and yield reveals that 10 to 30% lime sludge applied in the soil has increased the height of the plants, number of seeds and dry weight of rice. Physicochemical characteristics of sludge mixed soil at the time of plantation and after harvesting have shown significant change in pH, conductivity, Sodium, Potassium, Nitrogen etc. © Enviromedia Printed in India. All rights reserved. © 2009 Elsevier B.V. All rights reserved.

715. Phytotoxicity of organic amendments on activities of select soil enzymes.

Madejon, E.; Burgos, P.; Murillo, J. M.; and Cabrera, F.

Communications in Soil Science and Plant Analysis 32(13-14): 2227-2239. (2001)

NAL Call #: S590.C63; ISSN: 0010-3624

Descriptors: beta glucosidase/ composting/ composts/ cress/ enzyme activity/ heavy metals/ organic amendments/ oxidoreductases/ paper mill sludge/ phytotoxicity/ salinity/ sandy soils/ seed germination/ soil enzymes/ soil organic matter/ soil types/ solid wastes/ urease/ Capparales/ organic matter in soil/ redox enzymes

Abstract: Three organic materials, a municipal solid waste compost (MWC), a paper sludge (PS) and an agroforest compost (AC), were tested to relate their stability to the corresponding soil enzyme activity resulting from their application. PS and AC were stable materials, free of phytotoxic substances, although AC presented direct toxicity due to its high salinity and inhibited seed germination of *Lolium multiflorum* and *Lepidium sativum*. The presence of heavy metal does not seem playing an important role in the phytotoxicity of the tested materials since, the highest values of germination index were obtained with PS material despite its high heavy metals concentration. However, MWC presented a low level of maturity affecting negatively seed germination, and indicating an inaccurate composting process. The application of the three organic materials to a sandy soil (at a rate equivalent to ~50 000 kg ha⁻¹) increased soil enzyme activities (dehydrogenase [oxidoreductase], beta -

glucosidase, urease and benzoylargininamide hydrolyzing (BAA)) with respect to the control (soil without organic matter application) during one month of incubation. The positive effect of the organic materials on enzyme activities was more pronounced in the case of the MWC, a fresh organic residue having low organic matter stability. It suggested that the presence of phytotoxic substances did not affect negatively soil enzyme activities. Probably, molecules or promoters released by decomposing organic compounds which affect negatively seed germination, enhance enzyme activities.

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716. Plant foliar disease suppression mediated by composted forms of paper mill residuals exhibits molecular features of induced resistance.

Vallad, G. E.; Cooperband, L.; and Goodman, R. M.

Physiological and Molecular Plant Pathology 63(2): 65-77. (2003); ISSN: 0885-5765

Descriptors: defence mechanisms/ disease resistance/ elicitors/ genetically engineered organisms/ induced resistance/ industrial wastes/ leaves/ paper mill sludge/ pathogenesis/ plant diseases/ plant pathogenic bacteria/ plant pathogens/ residues/ soil amendments/ tomatoes/ transgenic plants/ waste utilization/ Capparales / defense mechanisms/ genetically engineered plants/ genetically modified plants/ GMOs/ phytopathogens/ resistance to disease

Abstract: *Arabidopsis thaliana* grown in soil from field plots amended with composted forms of paper mill residuals (PMR) exhibited reduced symptoms of bacterial speck caused by *Pseudomonas syringae* pv. tomato (Pst) compared with plants grown in soil from field plots amended with a non-composted PMR or non-amended soils. Similar results were obtained with tomato (*Lycopersicon esculentum* Mill.). No relationship between foliar disease suppression and plant nutrition or stature was observed. In *Arabidopsis*, the reduction of foliar disease symptoms ranged between 34 and 65%, depending on the type of composted PMR amendment, and was associated with reduced Pst titers in planta. An *Arabidopsis* npr1 defence mutant and a NahG transgenic line, both of which exhibit disrupted systemic acquired resistance, were also disrupted in their suppression of Pst disease symptoms in composted PMR treatments. *Arabidopsis* grown in soil amended with composted PMR also displayed an increased expression of pathogenesis-related defence genes prior to pathogen inoculation. We conclude that plants grown in soils with composted PMR-amendments were more resistant to disease caused by Pst due to the induction of plant defenses, similar to systemic acquired resistance. The identity of the PMR elicitor(s) is as yet unknown, but was shown to be heat labile. Reproduced with permission from the CAB Abstracts database.

717. Pore occlusion by sugars and lipids as a possible mechanism of aggregate stability in amended soils.

Hafida, Z.; Caron, J.; and Angers, D. A.

Soil Science Society of America Journal 71(6): 1831-1839. (Nov. 2007-Dec. 2007)

NAL Call #: 56.9 So3; ISSN: 0361-5995

Descriptors: soil aggregates/ aggregate stability/ soil pore system/ soil amendments/ pulp and paper sludge/

composts/ lipids/ sugars/ clay loam soils/ carbon/ mineralization/ swelling (materials)/ pressure/ silty clay loam soils / uronic sugars

Abstract: Understanding the underlying mechanisms of structural stability and the contribution of specific organic fractions to such mechanisms is critical in designing new soil and water conservation strategies relying on organic amendments. The objective of this work was to study the role of neutral and uronic sugars and lipids in affecting key mechanisms (swelling rate, pressure evolution) involved in the stabilization of individual aggregates. A 48-wk incubation study was performed on a clay loam and a silty clay loam amended with either deinking-secondary sludges, primary-secondary sludges, or composted deinking sludges at rates ranging from 8 to 24 Mg dry matter ha⁻¹. Different structural stability indices were measured during the incubation, along with CO₂ evolved, neutral and uronic sugar, and lipid contents. Significant increases in all stability indices were measured for both soil types. These improvements were linked to a very intense phase of C mineralization and highly correlated with neutral and uronic sugars as well as lipid contents. Paper sludge amendments also resulted in significant decreases in maximum internal pressure of aggregates and aggregate swelling following immersion in water, two mechanisms affecting structural stability. Overall, the results suggest that reduction in maximum internal pressure induced by organic amendments probably resulted from increases in pore surface roughness and pore occlusion rather than an increase in surface wetting angles. This study also supports the view of a nonspecific action of the lipids and neutral and uronic sugars on aggregate stability to rapid wetting. This citation is from AGRICOLA.

718. Potential for the large-scale production of a biocontrol fungus in raw and composted paper mill waste.

Ramona, Y. and Line, M. A.

Compost Science and Utilization 10(1): 57-62. (2002)
NAL Call #: TD796.5.C58 ; ISSN: 1065-657X

Descriptors: biological control/ composting/ growth/ industrial wastes/ paper mill sludge/ population density/ survival/ Hyphomycetes/ Leotiales/ Sclerotiniaceae

Abstract: The growth and survival of a *Trichoderma* spp. (Td₂₂) antagonistic to *Sclerotinia minor* and *Sclerotium cepivorum* was studied in raw wood fibre waste (WFW) of paper mill origin and in mature compost of this material. In nutrient-amended, sterilized WFW or WFW compost (both supplemented with 20% w/w millet seed), the biocontrol fungus reached densities in the order of 10¹⁰ colony forming units (cfu)/g after 14 days incubation. Lower population densities of Td₂₂ were achieved under non-sterile conditions in the compost:millet mix of between 10⁷-10⁹ cfu/g after 28 days, depending on pretreatment. Viable spore density of Td₂₂ in raw WFW amended with nutrients and 20% w/w millet seed reached approximately 10¹⁰ cells/g after 14 days incubation. This study indicates that cellulosic paper mill waste could provide an abundant low-cost growth medium for the large-scale culture of this or other biocontrol fungi.

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719. Potential mineralization of nitrogen from organic wastes to ryegrass and wheat crops.

Cordovil, C. M. d. S.; Cabral, F.; and Coutinho, J.

Bioresource Technology 98(17): 3265-3268. (Dec. 2007)
NAL Call #: TD930.A32 ; ISSN: 0960-8524.

Notes: In the special issue: Sustainable organic waste management for environmental protection and food safety / edited by M Pilar Bernal, R Moral and Sabine Hourot Paper presented at the "11th International Conference of the FAO ESCORENA Network on Recycling of Agricultural, Municipal and Industrial Residues in Agriculture", October 6-9 2004, Murcia, Spain.

Descriptors: agricultural soils/ soil amendments/ organic wastes/ municipal solid waste/ pulp and paper sludge/ poultry manure/ pig manure/ nitrogen/ mineralization/ Lolium/ Triticum aestivum/ wheat/ nutrient uptake

Abstract: Two-pot experiments with ryegrass and wheat plants were conducted in a Cambic Arenosol to test the reliability of N fate predicted by incubation experiments previously performed, with the same soil, to assess potentially mineralizable nitrogen from six organic wastes (municipal solid waste compost, secondary pulp mill sludge, horn meal, poultry manure, solid phase from pig slurry and composted pig manure). Two treatments, corresponding to 80 and 160 kg N/ha were tested, with or without mineral N fertilization. Experimental data obtained in the pot trials was consistent with nitrogen net mineralization trend observed in the aerobic incubations with all the wastes tested. Values of potentially mineralizable nitrogen (N(0)) from the equations obtained by model fitting, to the incubation data, were well correlated to ryegrass and wheat N uptake. Poultry manure was the most efficient N supplier to crops. This citation is from AGRICOLA.

720. Potentially mineralizable nitrogen from organic materials applied to a sandy soil: Fitting the one-pool exponential model.

Cordovil, C. M. d. S.; Coutinho, J.; Goss, M.; and Cabral, F.

Soil Use and Management 21(1): 65-72. (2005)
NAL Call #: S590.S68; ISSN: 0266-0032

Descriptors: biochemistry and molecular biophysics/ waste management: sanitation/ models and simulations: computational biology/ soil science/ one pool exponential mineralization model: mathematical and computer techniques/ aerobic incubation: laboratory techniques/ sandy soil/ water holding capacity/ poultry manure/ organic waste/ municipal waste/ cambic arenosol soil/ pulp mill sludge/ hornmeal/ pig slurry/ composted pig manure

Abstract: Over the last three decades there has been a great increase in the production of waste from urban, industrial and agricultural activity that could be recycled as a source of plant nutrients, and used to enhance soil quality. The use of these materials could partially offset the need for mineral fertilizers, giving both economic and environmental benefits. An incubation experiment was carried out using different organic waste materials applied to a Cambic Arenosol. Air-dried soil was mixed with increasing amounts of composted solid municipal waste, secondary pulp-mill sludge, hornmeal, poultry manure, solid phase from pig slurry, and composted pig manure, resulting in applications equivalent to 0, 40, 80, 120, 160 and 200 kg ha⁻¹ of Kjeldahl nitrogen. The samples were incubated for 244 days under a controlled environment of 24 degrees C

and 60% water holding capacity of the soil. The increasing amounts of waste applied always led to a greater amount of potentially available nitrogen present in the soil/waste mixture. Based on the proportion of their active N fraction, wastes were ranked: poultry manure > hornmeal > solid phase from pig slurry > composted pig manure > secondary pulp-mill sludge > composted municipal solid waste. The results were well described by a one-pool exponential mineralization model, and mineral N formation was proportional to the quantity of waste applied. Of the wastes tested, those from animal sources showed greater nitrogen mineralisation. Nitrification was rapid, and concentrations of ammonium nitrogen remained relatively small.

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721. Prediction of nitrogen mineralisation from organic residues and supply to ryegrass.

Cordovil, C. M. d. S.; Coutinho, J.; and Cabral, F. In: Controlling Nitrogen Flows and Losses. 12th Nitrogen Workshop. University of Exeter, UK.; pp. 156-157; 2004. *Descriptors:* Arenosols/ crop residues/ hoof and horn meal/ mineralization/ nitrogen/ nitrogen fertilizers/ nutrient uptake/ paper mill sludge/ prediction/ soil fertility/ soil types Reproduced with permission from the CAB Abstracts database.

722. Primary and secondary sludge composting: A feasibility study suggestions are offered on how to reduce the disposal problem.

Arrougé, T.; Moresoli, C.; and Soucy, G. *Pulp and Paper Canada* 100(4): 33-36. (1999); ISSN: 03164004 [PPCAA] *Descriptors:* composting/ costs/ sludge/ sludge disposal/ composting/ cost benefit analysis/ paper and pulp mills/ sewage treatment/ sludge disposal/ composting plants/ paper and pulp industry *Abstract:* The disposal of primary and secondary sludge is becoming a stringent problem for the pulp and paper industry. With the increasing costs of traditional disposal such as landfilling, the industry is seeking new alternatives. In this paper, the key parameters for the treatment of sludge to produce a high quality compost are discussed. In particular, the physical and chemical characteristics of the sludge, the composition of the raw materials mix and the design of the composting plant are addressed. A preliminary cost analysis is also presented. © 2009 Elsevier B.V. All rights reserved.

723. Production and partial characterisation of xylanase from Streptomyces sp. strain AMT -3 isolated from Brazilian cerrado soil.

Nascimento, R. P.; Coelho, R. R. R.; Marques, S. ; Alves, L.; Girio, F. M.; Bon, E. P. S.; and Amaral Collaco, M. T. *Enzyme and Microbial Technology* 31(4): 549-555. (2002); ISSN: 0141-0229 *Descriptors:* agroindustrial byproducts/ brewers' grains/ cerrado soils/ enzyme activity/ hemicelluloses/ isoenzymes/ maize cobs/ paper mill sludge/ soil bacteria/ temperature/ wheat bran/ wheat germ/ xylan/ endo 1,4 beta xylanase/ isozymes/ wood gum/ wood rosin *Abstract:* Streptomyces sp. AMT-3 strain previously isolated from Brazilian cerrado soil has been selected as a promising strain for xylanase production. This bacterial strain was able to produce a medium-high range of extracellular xylanolytic activity levels for liquid cultures

containing commercial xylans (birchwood, larchwood and oat spelts) and agroindustrial byproducts and wastes. Although the best xylanase production (70.0 U ml⁻¹) was obtained in growth medium containing larchwood xylan 1% (w/v), xylanolytic activity was also observed when wheat bran (28.4 U ml⁻¹), wheat germ (20.4 U ml⁻¹), brewer's spent grain (16.0 U ml⁻¹), maize cobs (9.1 U ml⁻¹) and paper recycling mill sludge (7.9 U ml⁻¹) were used as substrates. The Streptomyces sp. AMT-3 strain xylanase activity was characterized in terms of temperature and pH profiles and thermostability. Best enzyme activity was observed at the temperature range from 55 to 65 degrees C and at pH 6.0. The enzyme retained 50% of its activity after 20 h at 55 degrees C. As such, this xylanase could be considered as a thermotolerant biocatalyst being interesting for biotechnological applications. Zymogram analysis of the culture supernatant indicated the presence of several bands suggesting the presence of isoenzymes with different molecular weights. When cells were grown on agroindustrial byproducts lower molecular weight bands were more evident. Reproduced with permission from the CAB Abstracts database.

724. Pulp and paper industry's diverse organics stream.

Kunzler, C. *Biocycle* 42(5): 30-33. (2001) *NAL Call #:* 57.8 C734 ; ISSN: 02765055 [BCYCD] *Descriptors:* byproducts/ composting/ feedstocks/ fibers/ organic compounds/ sludge disposal/ wastewater treatment/ woodash/ paper and pulp industry/ kraft papers/ solid wastes *Abstract:* A variety of organic residuals are produced by the paper and pulp industry ranging from paper mill solids and wood ash to postconsumer recovered fiber. The by-products can be industrial sludges that are land applied or composted to postconsumer fibers that are part of the organic composting programs. Soils and crops receive plant nutrients and organic matters by the land application of pulp and paper residuals. The moderate to high level of organic matter with relatively low level of nutrients in the pulp and paper residuals depend on the specific mills. © 2009 Elsevier B.V. All rights reserved.

725. Pulp and paper mill by-products as soil amendments and plant nutrient sources.

Camberato, J. J.; Gagnon, B.; Angers, D. A.; Chantigny, M. H.; and Pan, W. L. *Canadian Journal of Soil Science* 86(4): 641-653. (2006) *NAL Call #:* 56.8 C162 ; ISSN: 00084271 [CJSSA] *Descriptors:* land application/ N and P immobilization/ nutrient efficiency/ paper mill sludge/ soil physical properties/ compost/ crop improvement/ crop production/ nutrient availability/ pulp and paper industry/ sludge/ soil amendment/ soil improvement/ soil organic matter/ soil property/ soil quality/ waste treatment *Abstract:* Pulp and paper mill sludges are produced from primary and secondary treatment of wastes derived from virgin wood fiber sources, recycled paper products, and non-wood fibers. Sludges and sludge composts may be utilized in agriculture to increase soil organic matter, improve soil physical properties, provide nutrients, and increase soil pH. Positive effects of primary, deinking, and low-nutrient combined sludges on soil quality are primarily

due to increased soil organic matter, aggregation, water holding capacity, infiltration rate, and cation exchange capacity. Nitrogen and P immobilization are often induced by primary and deinking sludges, but can be overcome by delayed planting, adding N and P, planting of legumes, or composting. Improved crop production obtained with secondary treatment sludges is most often attributable to enhanced nutrient availability, particularly N, but improved soil physical properties are implicated in some studies. Pulp and paper mill sludges and sludge composts are useful soil amendments and plant nutrient sources.

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726. Pulp sludge as a component in manufactured topsoil.

Carpenter, A. F. and Fernandez, I. J.
Journal of Environmental Quality 29(2): 387-397. (Mar. 2000-Apr. 2000)

NAL Call #: QH540.J6; ISSN: 0047-2425 [JEVQAA]

Descriptors: topsoil/ soil properties/ waste utilization/ soil amendments/ pollution control/ paper mill sludge

Abstract: The primary objective of this study was to evaluate the use of uncomposted, de-watered pulp sludge as the organic matter component in a manufactured topsoil. Seven manufactured topsoils, containing 5.1, 8.8, 9.6, 10.9, or 13.8% pulp sludge and 0, 8.4, or 20.7% flume grit on a dry weight basis, were applied to an abandoned gravel pit. Manufactured topsoils and a control topsoil were evaluated for (i) impacts on soil and soil solution chemistry and (ii) effectiveness as a growing medium for a grass conservation mix and hybrid poplars (*Populus* spp.). Significant N mineralization was evident in all of the manufactured topsoils within the first field season. Soil cation exchange capacity (CEC), pH and P availability were positively correlated to pulp sludge loading rate. In soil solution, the highest concentrations of solutes were detected within 2 mo of topsoil placement and were dominated by NO₃-N and Ca. Cumulative grass yields from the 15 mo following topsoil placement were greater than those in the control topsoil and ranged from 3.9 to 7.3 Mg ha⁻¹ in the manufactured topsoils. Tree height, diameter growth, and foliar nutrient concentrations responded positively to the manufactured topsoils. Results from this study indicate that topsoils manufactured with pulp sludge as the organic matter component can be an environmentally sound alternative to natural topsoil for the reclamation of sites on which existing conditions necessitate importing topsoil for revegetation. This citation is from AGRICOLA.

727. Quality of anaerobic compost from paper mill and municipal solid wastes for soil amendment.

Poggi-Varaldo, H. M.; Trejo-Espino, J.; Fernandez-Villagomez, G.; Esparza-Garcia, F.; Caffarel-Mendez, S.; and Rinderknecht-Seijas, N.

In: IAWQ Symposium on Forest Industry Wastewaters. Tampere (Finland). Luonsi, A. (eds.); Vol. 40. Pergamon, P.O. Box 800 Kidlington Oxford OX5 1DX UK: Elsevier Science Ltd.; pp. 179-186; 1999. ISBN: 0080437028

Descriptors: anaerobic digestion/ biochemical oxygen demand/ chemical oxygen demand/ compost/ composting/ composts/ experimental data/ germination/ heavy metals/ heavy metals/ land application/ municipal wastes/ municipal solid wastes/ organic acids/ oxygen/ oxygen uptake/ paper

industry wastes/ paper mills/ pulp and paper industry/ soil/ soil amendments/ solid wastes/ Europe/ United States/ organic acids

Abstract: Our previous work has shown the technical and economic feasibility of the solid substrate anaerobic digestion (DASS) of municipal and non-hazardous industrial solid wastes. However, the anaerobic compost (AnC) quality for direct application as a soil amender or other alternative uses are issues that have received scarce attention. This research aimed at reviewing the advances made by our Group in two areas: anaerobic compost quality determination, and its post-treatment by aerobic composting. A factorial experiment 4x2x2 was run. The factors were feedstock type (4 mixtures of food waste, FW, and lignocellulosic fraction, LG: 100%FW, 67%FW-33%LG, 33%FW-67%LG and 100%LG or FS1, FS2, FS3 and FS4 respectively), temperature (35 degree C and 55 degree C), and mass retention time (MRT, 16 and 23 days). The LG fraction consisted of paper mill sludge cake. Anaerobic compost from DASS reactors operated at 23 day/35 degree C) was fed to lab scale semi-continuous aerobic composters (5 day and 10 day MRT, 35 degree C and 55 degree C). The AnC coming from feedstocks with increasing proportion of LG fraction (FS3 and FS4) gave the lowest chemical oxygen demand (COD), biochemical oxygen demand (BOD), volatile organic acids (VOA) and total ammonia nitrogen (TAN) concentrations in the extract and the highest germination indices (GI). The AnC from thermo-digesters showed a lower quality than those from mesophilic reactors (presumably associated to higher contents of VOA and TAN in the extracts), while AnC from digesters at 23 day-MRT had a better quality than those from reactors operated at 16 day-MRT. Overall, AnC generated in reactors fed with FS3 and FS4, at 35 degree C and 23 day-MRT showed the highest quality. Heavy metal concentrations in all the AnC were lower than the maximum levels indicated in USA and European compost quality standards. However, high total oxygen uptake (UAD), moderate-to-high concentrations of VOA and GIs under 60% indicated that the AnC was not suitable for direct use as a soil improver. Regarding the aerobic post-composting, operation at longer MRT (10 day) and 55 degree C gave aerobic composts of better quality than those coming from 5 day-MRT composters. Aerobic post-composting caused considerable reductions of TAN, VOA, UAD, immediate oxygen demand rate, and increased compost GI up to approximately 100%.

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728. Reclaiming mined lands with biosolids, manures, and papermill sludges.

Haering, K. C.; Daniels, W. L.; and Feagley, S. E.
Reclamation of drastically disturbed lands: 615-644. (2000)

Descriptors: animal manures/ coal mined land/ environmental impact/ health/ paper mill sludge/ reclamation/ reviews/ sewage sludge/ soil amendments/ environmental effects/ United States of America

Abstract: The use of municipal biosolids (sewage sludge), animal manures, and paper mill wastes as mined land soil amendments are reviewed. Mine soils and mining wastes are generally lower in fertility and water holding capacity than natural topsoils and so benefit from the addition of

organic matter. The types of biosolids available, their benefits in land reclamation, health and environmental concerns, United States Environmental Protection Agency regulations concerning land application of biosolids, site-specific and regional research projects in Pennsylvania, Chicago and Virginia are discussed. Using animal manures in reclamation is briefly considered. Paper mill sludge characteristics and its use as a soil amendment are also examined.

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729. Reduction of Pb and Zn bioavailable forms in metal polluted soils due to paper mill sludge addition: Effects on Pb and Zn transferability to barley.

Battaglia, A.; Calace, N.; Nardi, E.; Petronio, B. M.; and Pietroletti, M.

Bioresource Technology 98(16): 2993-2999. (Nov. 2007)
NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: pulp and paper industry/ pulp and paper mills/ industrial wastes/ pulp and paper mill effluents/ pulp and paper sludge/ kaolinite/ polluted soils/ soil amendments/ heavy metals/ lead/ zinc/ reduction/ bioavailability/ soil pollution/ phytoremediation/ barley/ *Hordeum vulgare*/ plant physiology/ photosynthesis/ transpiration/ stomatal conductance/ peroxidase/ root growth

Abstract: In the last few years solidification/stabilisation of acidic soils polluted by heavy metals with low-cost sorbents has been investigated. Paper mill sludges are produced in large amounts and their disposal is a serious environmental problem. The possibility was therefore studied of using paper mill sludge as a stabilizer to reduce the bioavailable metal forms in polluted soils and thus the transferability of metals to plants (barley). We first investigated the sorbing properties of paper mill sludge for Zn(II) and Pb(II) and then their fractionation both in a polluted soil and in the same soil amended with paper mill sludge in order to check the decrease in mobile forms. Finally in both soils we tested the uptake of two metals by common barley in order to assess the performance of soil remediation from an ecological point of view. The addition of paper mill sludge to a soil contaminated by lead and zinc induces a decrease in the mobile forms of both metals, probably due to the presence in sludge of organic matter and kaolinite, which are able to bind the metals very strongly. The decrease in the mobile forms, which are the most readily available for uptake by plants, corresponds to a decrease in plant uptake. This citation is from AGRICOLA.

730. Reliability of a chemical method to assess nitrogen uptake by winter wheat.

Cordovil, C. M. d. S.; Coutinho, J.; and Cabral, F.

In: Controlling Nitrogen Flows and Losses. 12th Nitrogen Workshop. University of Exeter, UK.; pp. 158-159; 2004.

Descriptors: Arenosols/ biomass production/ hoof and horn meal/ methodology/ mineralization/ nitrogen/ nitrogen fertilizers/ nutrient uptake/ organic amendments/ paper mill sludge/ pig manure / pig slurry/ poultry manure/ refuse/ reliability/ soil types/ wheat/ winter wheat/ methods/ municipal wastes/ poultry litter/ trash

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731. Replacement of peat in growing substrates by paper mill waste materials.

Dubsky, M. and Sramek, F.

Zahradnictvi 25(3): 115-119. (1998)

Descriptors: bark/ cellulosic wastes/ clay/ composts/ culture media/ fibres/ flowering/ growing media/ growth retardation/ lignocellulosic wastes/ mixtures/ ornamental plants/ paper mill sludge/ peat/ physical properties/ pot plants/ quality/ substrates/ waste utilization/ wastes/ anthesis/ fibers/ ornamentals/ potting composts/ rooting media/ Saxifragales

Abstract: Substrates with peat replaced by paper mill waste materials (primary sludge, mixture of primary and secondary sludge, wood waste fibres) were tested in an experiment with pot plants of *Kalanchoe blossfeldiana*. As a control substrate a mixture of peat (40% by volume), composted bark (40%) and clay (20%) was used. In the test substrates, peat was partly or completely replaced by an alternative component. The physical properties of all substrates were good, and the chemical properties were also suitable. Only substrates with primary sludge and with a higher content of the sludges were higher in Ca and pH. *Kalanchoe* plants performed very well in substrates with 20 to 40% volume of wood waste fibres and no significant differences were found between the dimensions of plants cultivated in these substrates and in the control substrate. Plants cultivated in substrates with 30% primary sludge or with 20% of a sludge mixture also grew well. Very slight growth retardation was found in substrates with 30% or 40% of sludge mixture where significant differences in plant width were found at the end of the experiment. Nevertheless all plant were of good marketable quality and no differences were found in flowering.

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732. Researchers study vermicomposting of municipal and papermill sludges.

Ceccanti, B. and Masciandro, G.

Biocycle 40(6): 71-72. (1999)

NAL Call #: 57.8 C734 ; ISSN: 0276-5055

Descriptors: paper mill sludge/ sewage sludge/ sludges/ vermicomposting

Abstract: Pilot and field scale tests into vermicomposting, carried out in Pisa, Italy, are described. These trials evaluated the potential of vermicomposting as an economical/environmental alternative for sludge management. The experiments were performed on mixtures of aerobic sewage sludge and anaerobically treated paper mill sludge. The characteristics and agronomic value of the obtained vermicompost are discussed. Following physical and biological conditioning through an accelerated aerobic composting at the end of the vermicomposting process, a high-quality humic product is obtained for use as a soil organic amendment. Reproduced with permission from the CAB Abstracts database.

733. Responses of invertebrates to paper sludge application to soil.

Pearce, T. G. and Boone, G. C.

Applied Soil Ecology 9(1/3): 393-397. (1998)

NAL Call #: QH541.5.S6 A67

Descriptors: application to land/ arable soils/ paper mill sludge/ sandy soils/ soil/ soil amendments/ Britain/ land application/ United Kingdom

Abstract: An area of sandy arable soil in the UK which had been treated with paper sludge (200 t ha⁻¹) supported a much greater abundance of lumbricid earthworms (*Aporrectodea caliginosa* and *Octolasion cyaneum*, endogeic species) at the end of an exceptionally dry summer than adjacent untreated soil. In soil selection tests the endogeic *A. rosea* showed no discrimination between arable soil with and without paper sludges produced by two different processes. It did, however, strongly select sandy moorland soil which had been treated with either paper sludge, and had a pH near 7, over unamended moorland soil of pH 3.9. Similar responses were observed for the herbivorous gastropod *Helix aspersa*. The anecic lumbricid *Lumbricus terrestris* drew substantial amounts of both kinds of paper sludge into its burrow, although comparatively slowly compared with decaying leaf material. *Helix aspersa* readily consumed one of the two sludges. Implications of sludge application for faunal abundance and diversity, and likely effects on soil fertility, are outlined. Reproduced with permission from the CAB Abstracts database.

734. Responses of *Salsola kali* and *Panicum virgatum* to mycorrhizal fungi, phosphorus and soil organic matter: Implications for reclamation.

Johnson, N. C.

Journal of Applied Ecology 35(1): 86-94. (1998)

NAL Call #: 410 J828; ISSN: 0021-8901

Descriptors: fertilizers/ guidelines/ halophytes/ industrial wastes/ mine spoil/ paper mill sludge/ phosphorus fertilizers/ plant pathology/ reclamation/ root inoculation/ soil organic matter/ vesicular arbuscular mycorrhizas/ mine wastes/ mining spoil/ mining wastes/ organic matter in soil/ phosphate fertilizers/ phytopathology/ recommendations/ taconite/ United States of America

Abstract: Unreclaimed taconite mine tailings in Arizona, USA, were used as a mycorrhiza-free ecosystem to gain insights about the influence of vesicular-arbuscular mycorrhizas (VAM) and soil organic matter on the growth of *Salsola kali* (an early successional colonist of taconite tailings) and *Panicum virgatum* (a late successional grass planted during reclamation). To assess relative mycorrhizal responsiveness, *P. virgatum* and *S. kali* were grown in taconite tailings along an experimental phosphorus gradient with and without VAM inoculum isolated from reclaimed taconite tailings. At low phosphorus concentrations, VAM inoculation of roots enhanced the growth (height and dry mass) of *P. virgatum*, but it decreased growth at the two highest phosphorus concentrations. At no phosphorus level did VAM inoculum enhance the growth of *S. kali* but it decreased growth at the highest phosphorus concentrations. In field plots, mycorrhizal inoculum and organic soil amendment (composted paper mill sludge) enhanced the growth of *P. virgatum* and decreased the growth of *S. kali*. Large-scale inoculation of reclamation sites, increasing soil organic matter and avoidance of high rates of fertilizers was recommended.

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735. Restoration of ecosystem function in an abandoned sandpit: Plant and soil responses to paper de-inking sludge.

Fierro, A.; Angers, D. A.; and Beauchamp, C. J.

Journal of Applied Ecology 36(2): 244-253. (1999)

NAL Call #: 410 J828; ISSN: 0021-8901

Descriptors: application rates/ biomass/ bulk density/ cation exchange/ fertilizers/ industrial wastes/ mine spoil/ mineral uptake/ nitrogen/ nitrogen fertilizers/ paper mill sludge/ phosphorus/ phosphorus fertilizers/ reclamation/ revegetation/ sand pits/ seasons/ sludges/ soil amendments/ sustainability/ mine wastes/ mining spoil/ mining wastes/ phosphate fertilizers

Abstract: In mine spoil reclamation, the establishment of a sustainable plant cover requires the improvement of limiting conditions and the re-initiation of carbon (C) and nutrient cycling. The approach used in this study for reclaiming an abandoned sandpit in Quebec, Canada, was based on a heavy organic amendment as an attempt to accelerate the reconstruction of a functional ecosystem. The single intervention consisted of incorporating paper de-inking sludge into soil at two rates (0 and 105 dry t/ha), supplemented with nitrogen (N) at three rates (3, 6 and 9 g/kg sludge) and phosphorus (P) at two rates (0.5 and 1.0 g/kg sludge) followed by sowing (mid-summer) of *Agropyron elongatum* [*Elymus elongatus*]. Standing biomass increased in the presence of sludge after both the first and second full growing seasons. High N application rates further increased yield, more importantly in the second season. The high P rate improved grass establishment in all cases. Ground cover increased with time and doubled in the presence of sludge whereas it decreased in the absence of sludge. P and N uptake were improved consistently in the presence of sludge. Sludge application resulted in improved water retention and cation exchange capacities, and an increase in pH and bulk density of sand pit mine spoil, all of which may have accounted for the significant improvement in plant responses. Levels of soil C and N suggest that this reconstructed system approached sustainability. Adequate N and P supplements will accentuate the positive influence of sludge on revegetation.

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736. Reutilization of a paper factory effluent and waste.

Chatterjee, A. K.

Reutilization of Industrial Effluents and Waste: 101-104. (2001)

Descriptors: agricultural wastes/ dyes/ environmental protection/ fly ash/ irrigation/ lignosulfonates/ magnesium/ organic fertilizers/ paper mill sludge/ pollution control/ powders/ pulp and paper industry/ pulp mill effluent/ pulping/ rice husks/ sodium/ waste management/ waste treatment/ waste utilization/ waste water treatment/ water reuse/ dyestuffs/ farm wastes/ kraft mill effluent/ lignin sulfonate/ lignin sulphonate/ lignosulphonates / paper industry/ rice hulls/ watering

Abstract: The Shiva paper mill, located in Jain Nagar, Uttar Pradesh, India, was established in 1980 and processes mainly agricultural residues (bagasse, wheat straw, rice straw and grasses). This integrated mill has adopted environmentally friendly technology for the pulping process,

and has made great efforts to maintain the ecosystem and the environment free from pollution. Treated effluents are being used by the farmers from nearby villages for irrigation purposes. The paper mill also uses rice husks as a fuel which generates wastes in the form of fly ash. This waste can be used as a fertilizer. The commercial production of three types of lignosulfonates (viz., sodium, magnesium and ferro chrome) from black liquor are detailed. The various applications of these lignosulfonate products, in lye and in powder form, are discussed. Reproduced with permission from the CAB Abstracts database.

737. Selection of biological agents from composts for control of damping-off of cucumber caused by *Pythium ultimum*.

Carisse, O.; Bernier, J.; and Benhamou, N.
Canadian Journal of Plant Pathology 25(3): 258-267.
(2003); ISSN: 0706-0661

Descriptors: biological control/ biological control agents/ composts/ cucumbers/ fungal diseases/ manures/ paper mill sludge/ plant disease control/ plant diseases/ plant pathogenic fungi/ plant pathogens/ plant residues/ *Bacillus marinus*/ biocontrol agents/ biological control organisms/ gherkins/ *Graphium putredinis*/ *Hyphomycetes*/ *Penicillium thomii*/ *Peronosporomycetes*/ *phytopathogens*/ *Pythiaceae*/ *Straminipila*/ *Zygorrhinchus moelleri*

Abstract: The microflora of three composts were studied to isolate and test microorganisms for biological control of *Pythium ultimum* on greenhouse-grown cucumber. A more diverse bacterial population was observed in compost from paper mill sludge (170 groups) than in composts from plant waste and from manure (75 and 88 groups, respectively). In compost from paper mill sludge, 12 fungal species were isolated, compared with 22 and 26 in composts from plant waste and from manure, respectively. Selected bacterial and fungal isolates were evaluated in assays on agar plates against *P. ultimum*. A total of 10 bacterial isolates and 4 fungal isolates significantly ($P \leq 0.0001$) reduced *P. ultimum* growth rate. These isolates were evaluated in the greenhouse for control of damping-off of cucumber. Disease incidence and severity and foliage and root masses were measured 3 weeks after soil inoculation with the microbial agents and *P. ultimum*. Under greenhouse conditions, *Zygorrhinchus moelleri* and *Bacillus marinus* were the most effective microorganisms against damping-off, followed by *Penicillium thomii*, *Pseudomonas fluorescens*, *Pseudomonas aeruginosa*, and *Graphium putredinis*. These isolates were tested in a second greenhouse trial and the best control was achieved with *Z. moelleri* and *Penicillium thomii*. Reproduced with permission from the CAB Abstracts database.

738. Sequential extraction of metals from artificially contaminated soils in the presence of various composts.

Madrid, L.; Diaz Barrientos, E.; and Cardo, I.
Trace Elements In Soil: Bioavailability, Flux and Transfer. 43-62. (2001)

Descriptors: composts / copper/ extraction/ Inceptisols/ iron/ lead/ manganese/ nickel/ olive oil/ paper mill sludge/ polluted soils/ refuse/ sandy soils/ soil pollution/ soil types/ strawberries/ temperature/ zinc/ Mn/ municipal wastes/ trash

Abstract: This study investigates the effect of adding to the soil of several composted residues on the distribution of metals added to the soil in soluble form. The possible effect of temperature is also tested. A method developed by the European Union's Community Bureau of Reference (BCR) was used as a sequential extraction procedure. A sandy, surface sample of a Typic Endoquept soil from a strawberry-growing area in southwestern Spain was collected. This soil was amended with three composts: composted urban residues (USR), composted wastes from paper industry (WPI), and composted residues from the olive oil industry (OI). The metal forms with environmental significance can be grouped into three fractions, sequentially extracted by 0.11 M CH_3COOH (f1), $\text{NH}_2\text{OH}\cdot\text{HCl}$ at pH 2 (f2), and $\text{CH}_3\text{COONH}_4$ at pH 5 after digestion with H_2O_2 at 85+or-5 degrees C (f3). Results showed that f1 for Zn does not undergo any significant variation due to the presence of OI or USR, while the presence of WPI causes a significant increase in f1. For Cu, the most available fraction, f1, undergoes a marked decrease with the doses of OI (more than 50% units) or USR (~30% units), but it is not sensitive to WPI, f2 and f3 markedly increase with the doses of any compost. For the distribution of Ni, the influence of the doses of any compost on f1 seems to be small and not consistent. Only OI seems to cause some depressing effect on this fraction, f2 shows a consistent increase with the doses of the three composts. For Pb, the most soluble fraction f1 is clearly depressed by the three composts, causing decreases of 13-37% from dose 0-3 (23-38% in the 2-week samples). The proportion of Mn in the soil (native+that present in the composts) that can be mobilized in the three fractions is initially clearly smaller than those observed for the other metals, except in the case of the higher dose of WPI. The proportion of extracted Fe is considerably lower than that of any of the other metals, and the distribution among the fractions is quite different: f1 is negligible, and f3 predominates with percentages somewhat greater than those for Zn, Ni, or Mn in this fraction.

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739. Short-term effects of deinking paper sludge on the dynamics of soil carbon, nitrogen, and phenolic compounds.

Machrafi, Y.; Chalifour, F. P.; Wamegni, J.; and Beauchamp, C. J.
Journal of agricultural and food chemistry 56(23): 11399-11406. (Dec. 2008)
NAL Call #: 381 J8223 ; ISSN: 1520-5118.
19007125

Descriptors: Carbon: analysis/ Germination/ Industrial Waste: analysis/ Nitrogen: analysis/ Phenols: analysis/ Plants: growth & development/ Refuse Disposal: methods/ Sewage: analysis/ -Soil: analysis

Abstract: Applications of deinking paper sludge (DPS) decreased the establishment of some crops, indicating that it may have inhibiting effects. The effects of soil-applied DPS on total carbon (C), nitrogen (N), C:N ratio, and nitrate, ammonium, and phenolic compounds were studied for 2 years. The phytotoxicity of simulated phenolic solutions of raw DPS and DPS-amended soil was investigated. Twelve phenolic compounds were quantified in raw DPS. Vanillin and 3-hydroxy-4-methoxycinnamic acids increased with DPS applications in amended soil for

both years. Total soil C and the C:N ratio increased with DPS applications, while nitrate soil content decreased. Germination indices were affected differently by the phenolic compound solution that simulated DPS. This study highlights the lack of availability of nitrate as the main factor involved in the inhibiting effect of DPS. However, other inhibiting effects of phenolic compounds cannot be ruled out since they are known to inhibit nitrification and to trap nitrate into organic N compounds. This citation is from PubMed.

740. Short-term effects on soil properties and wheat production from secondary paper sludge application on two Mediterranean agricultural soils.

Rato Nunes, J.; Cabral, F.; and Lcdpez Picheiro, A. *Bioresource Technology* 99(11): 4935-4942. (July 2008)
NAL Call #: TD930.A32; ISSN: 0960-8524

Descriptors: soil properties/ wheat production/ secondary paper sludge/ soil amendment/ Mediterranean agricultural soils

Abstract: This study was conducted under greenhouse conditions to evaluate the potential use of SPS as a fertilizer, amendment and/or liming agent for wheat (*Triticum aestivum* L.). Two representative Mediterranean agricultural soils, a Cambic Arenosol (cmAR) and a Cromic Cambisol (crCM) were used. Treatments included four sludge rates ranging from 0 to 40gkg⁻¹ (equivalent of 0, 38, 88 and 120Mgha⁻¹). A significant increment in soil pH, organic carbon, N total, available P and exchangeable K were observed in both soils. Sludge application significantly increased N and decreased Zn, Mn and Cu concentrations in wheat. Wheat grain yields were reduced by 33% and 37% when 120MgSPSha⁻¹ was applied to cmAR and crCM soils, respectively, due apparently to unavailability of Mg. However, straw yields, with much lower Mg requirements, increased significantly with SPS rates. Secondary pulp mill sludge seems to be a potential source of organic matter, N, P, K and a potential soil amendment liming agent for acid soils, when appropriate supplemental fertilizer was provided. For grain crops grown in these soils, addition of Mg is required for proper nutrient balance. This citation is from AGRICOLA.

741. Soil Aggregation and Biochemical Properties following the Application of Fresh and Composted Organic Amendments.

Bipfubusa, M.; Angers, D. A.; N' Dayegamiye, A.; and Antoun, H.

Soil Science Society of America Journal 72(1): 160-166. (Jan. 2008-Feb. 2008)

NAL Call #: 56.9 So3; ISSN: 0361-5995

Descriptors: silt loam soils/ soil aggregates/ aggregate stability/ pulp and paper sludge/ composts/ humic substances/ amino sugars/ glucosamine/ microorganisms/ soil fungi/ soil organic carbon/ nitrogen fertilizers/ humification/ field experimentation

Abstract: The aim of this study was to evaluate the effects of fresh and composted paper sludge on macroaggregate stability of a silt loam under field conditions, and to assess the possible role of carbohydrate fractions and humic substances. The treatments included fresh paper mill sludge (PMS) and its compost (CPMS) applied at a rate of 40 Mg ha⁻¹ with or without a mineral N fertilizer (120 kg N ha⁻¹), N fertilizer only (recommended rate of 160 kg N ha⁻¹), and an unamended control. Measurements of total and

amino sugars and humic substances were made on slaking-resistant aggregates 2 yr after the last of three successive annual applications of the treatments. Compared with the treatments that received no organic amendment, the PMS and CPMS applications increased macroaggregate stability by an average of 45%. The effects of fresh vs. composted amendments on soil macroaggregates and their organic C contents were similar but differences in C composition were observed. Humic acid content of aggregates >2 mm was significantly higher (50%) with CPMS than PMS, although part of this effect could be attributed to the slightly greater C application rate with CPMS. Conversely, glucosamine content, an indicator of fungi abundance, was significantly greater following PMS than CPMS application. We concluded that microorganisms, in particular fungi, were a more important factor of stable macroaggregation in the soil amended with fresh sludge, while humic substances played a greater role in compost-amended soil. These effects were long lasting in the field since they were still noticeable 2 yr after the last application. This citation is from AGRICOLA.

742. Soil construction: A step for ecological reclamation of derelict lands.

Sere, G.; Schwartz, C.; Ouvrard, S.; Sauvage, C.; Renat, J. C.; and Morel, J. L.

Journal of Soils and Sediments 8(2): 130-136. (2008);
ISSN: 1439-0108

Descriptors: composts / contaminants/ drainage/ effluents/ industrial wastes/ organic wastes/ paper mill sludge/ polluted soils/ rain/ reclamation/ recycling/ soil conservation/ soil parent materials/ soil pollution/ soil profiles/ soil types/ waste utilization/ water balance/ rainfall

Abstract: Goal, Scope and Background. Efficient and environmentally friendly technologies for soil reclamation require efforts to develop innovative processes. Alternative technologies to drastic techniques (containment, total removal of soil) are receiving increasing interest. They are based either on the use of ameliorants (e.g. lime, fertilizer, organic mulch) and more recently on the spreading of organic wastes (e.g. compost, sewage sludge). This paper presents a new process of soil construction using wastes and industrial by-products which are formulated and stacked in layers to build a new soil profile over in situ degraded substrates. Work was conducted to assess the feasibility of the ecological reclamation, focusing on the major functions of constructed Technosols. Materials and Methods. Two large lysimetric plots (10x10 m) were built on a former coking plant, and two strategies of constructed soil profiles were compared: (i) a control soil using thermally treated industrial soil available in situ, and (ii) a constructed soil with a combination of thermally treated industrial soil mixed with exogenous materials such as green waste compost and paper mill sludge. Rainfall was measured periodically, drainage effluent was collected, and aliquots were sampled per plot. Plants were collected in 8 replicates for each plot. Results. Water balance data showed that about 10% of the rain water percolated through the constructed soil profiles. Drainage effluent contained a low concentration of contaminants, below the French water drinking standards. Plants grew without any deficiency symptoms on both plots. Apart from the sowed plants, indigenous species developed on the constructed Technosols. Discussion. The experimental set-up was

representative of the real conditions for the implementation of such reclamation technologies. In spite of the significant concentrations of trace elements in the parent materials, the fluxes in the drainage effluent were very low because of the high pH. Significantly higher biomass values were recorded on the constructed soil than on the control, as well as a better development of indigenous plants. Conclusions. The constructed soils are examples of Technosols as they are made exclusively of technogenic parent materials. Our results showed that they can behave like natural soils (water cycle, trace elements filtration, biomass production). The process of soil construction is not only an efficient way to reclaim derelict lands, but also a safe alternative for the recycling of wastes and by-products with a minimum use of unpolluted and fertile agricultural soil. Recommendations. The restoration of soil functions, thanks to the soil construction process, must be considered as a primary step for the ecological reclamation of derelict lands. In this way, the pedo-engineering approach should be considered as an essential part of the global ecological engineering for the reclamation of derelict lands. Perspectives. Two major outlooks appear: (i) testing a larger variety of wastes and by-products as parent materials for different constructed soils, (ii) generalize the results on constructed soils to the characterization of Technosols. Reproduced with permission from the CAB Abstracts database.

743. Soil enzymatic response to addition of heavy metals with organic residues.

Madejon, E.; Burgos, P.; Lopez, R.; and Cabrera, F. *Biology and Fertility of Soils* 34(3): 144-150. (2001) *NAL Call #:* QH84.8.B46; ISSN: 0178-2762
Descriptors: Alfisols / beta glucosidase/ chemical composition/ enzyme activity/ heavy metals/ Inceptisols/ organic carbon/ organic wastes/ oxidoreductases/ paper mill sludge/ phosphoric monoester hydrolases/ phosphorus/ refuse compost/ soil composition/ soil enzymes/ soil types/ solid wastes/ urease/ phosphatases/ redox enzymes/ town compost
Abstract: Changes in organic C, available P, available heavy metal contents and enzymatic activities induced by addition of two heavy metal rich organic residues (a municipal solid waste compost (MWC) and a non-composted paper sludge (PS)) were determined in two different soils (Typic Endoaquept and Typic Albaqualf) during a 280-day incubation experiment. The addition of the organic materials caused a rapid and significant increase in the organic C and enzymatic activities in both soils, this increase was specially noticeable in soils treated with MWC. In general, enzymatic activities in amended soils tended to decrease with the time. Organic materials also increased heavy metal contents in soil. However, the presence of available soil heavy metals due to the addition of the organic materials at doses of 50 000 kg ha⁻¹ did not negatively affect dehydrogenase [oxidoreductases], beta - glucosidase or urease activities in the soils. There were significant and negative correlations between heavy metals and phosphatase [phosphoric monoester hydrolases] activity in the soils at the beginning of the incubation. This negative correlation was probably due to the decrease in the enzyme activity in soils treated with PS in which high levels of available P were also found. It is difficult, therefore, to attribute an inhibition of the enzyme activity to

the presence of these heavy metals because a high available P concentration in soils also depresses phosphatase activity. Reproduced with permission from the CAB Abstracts database.

744. Soil enzyme activities following paper sludge addition in a winter cabbage-sweet corn rotation.

Gagnon, B.; Lalande, R.; Simard, R. R.; and Roy, M. *Canadian Journal of Soil Science* 80(1): 91-97. (2000) *NAL Call #:* 56.8 C162 ; ISSN: 0008-4271
Descriptors: acid phosphatase/ alkaline phosphatase/ ammonium nitrate/ application rates/ arylsulfatase/ cabbages/ enzyme activity/ horticultural soils/ horticulture/ maize/ nitrate/ nutrients/ paper mill sludge/ phosphoric monoester hydrolases/ requirements/ rotations/ sludges/ soil/ sweetcorn/ treatment/ winter/ acid phosphomonoesterase/ alkaline phosphomonoesterase/ arylsulphatase/ Capparales/ corn/ crop rotation/ phosphatases/ rotational cropping
Abstract: Combined primary and secondary paper mill sludge (PS) is a good source of C and other nutrients for horticultural soils. A field study was conducted to evaluate the effect of PS, spring-applied alone or in combination with ammonium nitrate (AN), on the enzymatic activity of a Bedford clay (Humic Gleysol) in Quebec, Canada. The experiment was started in 1996 with winter cabbage (*Brassica oleracea* var. capitata) and continued in 1997 and 1998 on the same plots with sweetcorn. The PS was applied at 0 (control), 8, 16, 32 and 65 t ha⁻¹ in 1996 and at 44% of these rates in 1997. No sludge was applied in 1998. Additional treatments consisted of AN applied yearly at 100% of the plant N requirements and a PS and AN combination. Soil arylsulfatase and acid and alkaline phosphatase activities were measured at three different times in each growing season. The PS rate linearly increased the soil acid phosphatase activity in all 3 years. In contrast, the alkaline phosphatase and arylsulfatase activities were enhanced in 1997 by the 8-16 t PS ha⁻¹ treatments, whereas larger amounts of PS showed activity comparable to the control. The second PS application promoted phosphatase activities mostly in the autumn, but did not sustain arylsulfatase activity. The AN gave lower phosphatase activities than PS, and depressed arylsulfatase. Addition of AN to PS increased only acid phosphatase activity as compared with PS alone or the control. This study indicated that addition of PS improved enzyme activity of this horticultural soil but rates in excess to 32 t ha⁻¹ may be detrimental. Reproduced with permission from the CAB Abstracts database.

745. Soil properties associated with organic matter-mediated suppression of bean root rot in field soil amended with fresh and composted paper mill residuals.

Rotenberg, D.; Wells, A. J.; Chapman, E. J.; Whitfield, A. E.; Goodman, R. M.; and Cooperband, L. R. *Soil Biology and Biochemistry* 39(11): 2936-2948. (2007) *NAL Call #:* S592.7.A1S6; ISSN: 0038-0717
Descriptors: composts / fungal diseases/ microbial activities/ microbial flora/ microbiology/ paper mill sludge/ plant disease control/ plant diseases/ plant pathogenic fungi/ plant pathogens/ rhizosphere/ root rots/ soil

amendments/ soil bacteria/ soil chemical properties/ soil organic matter/ soil physical properties/ chemical properties of soil/ green bean/ microbial communities/ microflora/ organic matter in soil/ physical properties of soil/ phytopathogens/ snap bean

Abstract: The ability of an organic amendment to suppress soil-borne disease is mediated by the complex interactions between biotic and abiotic soil factors. Various microbiological and physicochemical soil properties were measured in field soils with histories of receiving 4 or 5 years of spring additions of paper mill residuals (PMR), PMR composted alone (PMRC), PMR composted with bark (PMRB), or no amendment under a conventionally managed vegetable crop rotation. The objectives of this study were to (i) determine the residual and re-amendment effects of the organic materials on root rot disease severity; (ii) determine the influence of amendment type on the structure of bacterial communities associated with snap bean roots grown in these soils; and (iii) quantify the relative contributions of microbiological and physicochemical properties to root rot suppression in the field and greenhouse. While all amendment types significantly suppressed root rot disease compared to non-amended soils in both environments, only soils amended with PMR or PMRB sustained suppressive conditions 1 year after the most recent amendment event. Disease severity was inversely related to microbial activity (fluorescein diacetate assay) in recently amended soils only. Terminal restriction fragment length polymorphism (T-RFLP) analysis of the 16s rRNA gene was performed to obtain bacterial profiles. Principal component analysis (PCA) of terminal restriction fragments (TRFs) revealed general differences in bacterial community composition (PC1) among amendment types, and specific TRFs contributed to these differences. Correlation and multiple regression analyses of the measured soil variables revealed that the composition of root-associated bacterial communities and the amount of particulate organic matter-carbon in bulk soils imparted independent and relatively equal contributions to the variation in disease severity documented in the field and greenhouse. Together, our findings provide evidence that disease suppression induced by annual PMR inputs was mediated by their differential effects on bacterial communities and the amount and quality of organic matter in these soils.

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746. Sources and pathogenicity of Escherichia coli isolated from pulp and paper mill biosolids.

Renner, V. E.; Croteau, M. C.; Ridal, J. J.; Archibald, F. S.; and Lean, D. R. S.

In: Annual Conference on Great Lakes Research. Great Lakes in a Changing Environment. Windsor, ON (Canada.); Vol. 49.

Ann Arbor MI : International Association for Great Lakes Research; pp. [np]; 2006.

<http://www.iaglr.org/conference/>

Descriptors: assay/ DNA/ effluents/ Escherichia coli/ freshwater pollution/ hardwood/ industrial wastewater / industrial wastes/ microbial contamination/ nucleotide sequence/ polymerase chain reaction/ pulp and paper industry/ recreational waters/ strain/ toxicants/ toxins/ virulence/ escherichia coli/ North America, Great Lakes

Abstract: Pulp and paper mill biosolids have excellent properties as a soil conditioner. However, these biosolids contain high levels of E.coli. Since E.coli are typically used as an indicator of fecal contamination to assess the safety of drinking and recreational waters, their presence in pulp and paper mill biosolids is of concern. Previous research has shown that these bacteria grow prolifically within pulp and paper mill effluents in the absence of any known fecal source. This research was designed to identify the sources of E.coli to the mill. REP (repetitive extragenic palindromic) and ERIC (enterobacterial repetitive intergenic consensus) PCR were used to generate highly discriminatory fingerprints. Biosolids isolates were compared to isolates from potential sources (feed water, mill fibre, stormwater, wood chips, and forest samples). Biosolids isolates were also screened for the presence of E.coli virulence factors LT (heat labile toxin), ST (heat stable toxin) and VT (verotoxin) using commercially available oligonucleotide primers in a presence/absence based PCR assay. None of the E.coli isolates (n=110), collected over a 3-year period, carried these virulence factors. It seems unlikely that pulp and paper mill biosolids act as a reservoir for pathogenic strains of E.coli.

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747. Stability indices for different composts.

Eggen, T. and Vethe, O.

Compost Science and Utilization 9(1): 19-26. (2001)

NAL Call #: TD796.5.C58 ; ISSN: 1065-657X

Descriptors: composting/ composts/ fish scrap/ humification/ indexes/ organic carbon/ organic nitrogen/ paper mill sludge/ respiration rate/ sewage sludge/ sludges/ sodium hydroxide/ stability/ fish waste

Abstract: Four types of compost (paper mill sludge compost, fish compost, biowaste compost from windrow composting treatment and biowaste compost from reactor treatment) were used to evaluate several chemical parameters, which served as stability indices replacing respiration rate. Compost matter, water extracts and NaOH extracts were analysed. When all composts were statistically treated together, water soluble TOC (total organic carbon) was the only parameter that correlated significantly with respiration rate ($r^2=0.82$, $P<0.0001$). This is suggested as an operational parameter at composting plants. Data in this study supported neither the C:N ratio nor the humification HA:FA ratio as stability indices. When treating only biowaste composts statistically together, TOC (in fulvic acid fraction) and water soluble nitrogen (total and organic) were chemical indices that correlated with respiration rate.

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748. Stability of structural form during infiltration: Laboratory measurements on the effect of de-inking sludge.

Nemati, M. R.; Caron, J.; and Gallichand, J.

Soil Science Society of America Journal 64(2): 543-552.

(Mar. 2000-Apr. 2000)

NAL Call #: 56.9 So3; ISSN: 0361-5995 [SSSJD4]

Descriptors: soil types/ soil structure/ soil physical properties/ application rate/ aggregate stability/ infiltration/ wetting/ stability/ paper mill sludge/ wetting rate

Abstract: An adequate understanding of the mechanisms involved in the structural stabilization of soil by different sources of organic matter is needed to help design management strategies aimed at maintaining a stable soil structure. The objective of this study was to identify mechanisms involved in soil structure stabilization by paper sludge application, either by increasing the soil resistance to external stresses (aggregate stability) or by decreasing the magnitude of the external stresses (diminution of the wetting rate). A laboratory study was conducted on three different soil types with application of paper sludge at three rates (8, 16, and 24 dry t ha⁻¹). The mean weight diameter, bulk density, hydraulic conductivity, and water retention properties were measured before and after a wetting event. The results indicate that most of the changes in physical properties resulting from rapid wetting took place at the soil surface (0-50mm) and the magnitude of these changes gradually decreased down to a depth of 150mm. Paper sludge application significantly improved the stability of 1- to 4-mm aggregates to the destructive action of wetting in all three soil types. Paper sludge application increased porosity at potential > -2 kPa, which resulted in higher hydraulic conductivity values (up to 88%) and a smaller increase in soil bulk density (down to 67%) relative to a control following rapid wetting. The wetting rates observed during the wetting event were similar regardless of the treatment, because the increase in the water potential at the wetting front was compensated for by an increase in hydraulic conductivity with increasing rates of sludge application. This citation is from AGRICOLA.

749. Studies on the influence of paper mill effluents on the yield, availability and uptake of nutrients in rice.

Achari, M. S.; Dhakshinamoorthy, M.; and Arunachalam, G. *Journal of the Indian Society of Soil Science* 47(2): 276-280. (1999)

NAL Call #: 56.9 IN2; ISSN: 0019-638X

Descriptors: adverse effects/ availability/ biochemical oxygen demand/ effluents/ grain/ iron/ irrigation/ manganese/ nutrients/ paper mill sludge/ pollution/ pulp and paper industry/ rice/ soil/ soil amendments/ trace elements/ uptake/ yields/ zinc/ adverse reactions/ BOD/ environmental pollution/ microelements/ Mn/ paddy/ paper industry/ watering

Abstract: Paper mill effluent was analysed and applied at differing amounts with irrigation water, NPK fertilizers and soil amendments on a rice test crop. The undiluted effluent was dark brown in colour, had slightly alkaline pH, high biochemical oxygen demand, chemical oxygen demand, and electrical conductivity (EC), with appreciable quantities of Cl⁻, SO₄²⁻ and HCO₃⁻ of Ca, Mg, and Na and varying amounts of micronutrients. Soils irrigated with paper mill effluent had a higher pH and EC. Effluent irrigation, in general, increased the available N and K and decreased available P. DTPA-extractable Fe, Mn, Zn and Cu were also increased due to effluent irrigation. Effluent irrigation did not affect the grain yield. These results suggest the possibility of using paper mill effluent for irrigating rice crop without a major adverse effect on the growth and yield. Reproduced with permission from the CAB Abstracts database.

750. Study on the effects of paper-mill effluents on the growth and chlorophyll content of Pennisetum typhoideum.

Pritima, R. A.

Nature, Environment and Pollution Technology 1(2): 127-130. (2002); ISSN: 0972-6268

Descriptors: agriculture/ chlorophyll/ effluent/ growth/ industrial wastewater/ industrial effluents/ industrial waste waters/ irrigation/ irrigation water/ paper industry wastes/ plant physiology/ plants/ plants (see also aquatic macrophytes)/ pulp and paper industry/ pulp and paper industry waste waters (general)/ vegetation effects/ wastewater disposal/ wastewater irrigation/ water pollution effects

Abstract: Untreated, treated and enriched effluents of a paper-mill were analysed to find out the quantity of suspended solids, pH, chlorides, sulphates and others. These were highly reduced in treated and enriched effluents. Biochemical and chemical oxygen demands decreased considerably. Plants irrigated with treated and enriched effluents showed greater shoot, total length and higher chlorophyll (a, b and total) content, indicating the importance of treatment and enrichment of effluents.

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751. Sugarcane yields and soil analysis following application of paper mill sludge.

Legendre, B. L.; Bischoff, K. P.; Gravois, K. A. ; Hendrick, R. D.; and Arceneaux, A. E.

Journal American Society of Sugar Cane Technologists 24: 60-65. (2004)

Descriptors: ammonium nitrate/ application rates/ crop yield/ fertilizer requirement determination/ nitrogen fertilizers/ paper mill sludge/ soil ph/ sucrose/ sugar content/ sugar yield/ sugarcane/ waste utilization/ saccharose/ United States of America

Abstract: A study was conducted in Louisiana, USA to determine the effect of paper mill primary clarifier sludge in combination with various fertilizer treatments on cane and sugar yields of a sugarcane (*Saccharum officinarum*) plant cane through second ratoon crop cycle. Sludge was applied to fallow fields subsequently planted to sugarcane hybrids. The paper mill sludge was applied at rates of 0, 22.5, and 44.7 Mt per hectare on whole plots. Spring (0-0-0, 90-0-0, and 180-0-0) and starter (0-0-0 and 17-50-50) fertilizer treatments (kg ha⁻¹) were subplots. Soil pH was raised 0.3 units at the 44 Mt per hectare paper mill sludge rate when sampled the following spring after the autumn application. At the end of the experiment, soil pH for the 44 Mt per hectare rate was 0.8 units higher than the control. Spring fertilizer treatments resulted in significantly higher cane and sugar yields in ratoon crops, but not in the plant cane crop. Sludge and starter fertilizer treatments did not affect sugarcane yields. In the first ratoon crop, the highest sludge and the highest spring fertilizer rates produced significantly less sucrose content, but did not affect total sugar yield. Excess nitrogen can delay the accumulation of sucrose (maturity) in sugarcane. Therefore, if sludge is applied to sugarcane in Louisiana, nitrogen fertilizer should be applied at the lower end of the recommended range to the first

ratoon crop. In second-ratoon, sludge and spring fertilizer did not significantly affect sucrose content. The main effect of paper mill sludge appears to be the ability to raise soil pH.

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752. Suitability of sludges from dairy and paper industries for growth and reproduction of *Eisenia andrei*.

Elvira, C.; Sampedro, L.; and Nogales, R.

Pedobiologia 43(6): 766-770. (1999)

NAL Call #: 56.8 P343 ; ISSN: 0031-4056

Descriptors: analysis / cattle manure/ cocoons/ dairy effluent/ manures/ mixtures/ paper mill sludge/ reproduction/ sludges/ substrates/ vermicomposting/ wastes/ *Eisenia andrei*

Abstract: Sludges from a paper-mill and a dairy processing factory were used to grow *Eisenia andrei*. The growth and reproduction of this earthworm species in pure wastes and nine different mixtures of them with cattle manure have been studied weekly over 72 days. Earthworms grew at rates ranging from 6 to 12 mg worm⁻¹ day⁻¹ and cocoons were produced in all the substrates (average rate: 0.06-1.1 cocoon adult worm⁻¹ week⁻¹) with the exception of the pure dairy sludge. Those mixtures with 30% (d.w.) of paper sludge and manure, and those with the three wastes together were the most favourable for vermicomposting according to Principal Components Analysis of the growth and reproduction data.

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753. Suppression of soilborne diseases in field agricultural systems: Organic matter management, cover cropping, and other cultural practices.

Stone, A. G.; Scheuerell, S. J.; and Darby, H. M.

Soil Organic Matter in Sustainable Agriculture: 131-177. (2004)

Descriptors: antibiotics/ application rates/ cattle manure/ composts/ cover crops/ cropping systems/ cultural control/ decomposition/ farming systems/ fungal diseases/ microbial activities/ nutrient content/ nutritional state/ orchards/ organic amendments/ paper mill sludge/ plant breeding/ plant disease control/ plant diseases/ plant nutrition/ plant pathogenic fungi/ plant pathogens/ reviews/ rotations/ soil amendments/ soil organic matter/ soil physical properties/ soil types/ suppression/ suppressive soils/ tillage / agricultural systems/ crop rotation/ Hyphomycetes/ nutritional status/ organic matter in soil/ Peronosporomycetes/ physical properties of soil/ phytopathogens/ Pythiaceae/ rotational cropping/ soil cultivation / Straminipila

Abstract: This paper discusses organic matter (OM) management, cover cropping and other cultural practices to suppress soilborne diseases in field agricultural systems. The concept of suppressive soils and the types of disease suppression are reviewed. The relationships between OM quality and OM-mediated general suppression of diseases (caused by *Pythium* spp. and *Phytophthora* spp.) in container mixes are described. Discussions also include the interpretations of data on OM-mediated general suppression in natural soil systems and field agricultural systems (orchard systems, Chinampa agricultural systems,

field soils amended with paper mill residuals and field soils amended with dairy manure solids). OM-mediated general suppression of plant diseases through the manipulation of soil organic matter (SOM) during early stages of organic matter decomposition and later stages of decomposition is also presented. Soil amendment rates (high-rate organic amendment and low-rate organic amendment), serial amendment (organic soil management or long-term soil-building) and OM-mediated specific suppression of diseases caused by *Fusarium oxysporum* and *Rhizoctonia solani* in soilless container media and field soils are discussed. Also covered are the specific mechanisms such as microbiostasis, microbial colonization of pathogen propagules, destruction of pathogen propagules, antibiotics, competition for substrate colonization, competition for root infection sites and induced systemic resistance involved in biologically and OM-mediated disease suppression. The effects of SOM management on soil and plant nutrient status (macronutrients and micronutrients) and soil physical properties are briefly explained. A toolbox of cultural practices such as SOM management, crop rotation, cover and rotation crops and tillage and inputs like plant genetics, organic amendments, formulated amendments, high N-content amendments and inorganic amendments that could be used by farmers and scientists to generate disease-suppressive soils and cropping systems is also reviewed. Finally, some examples of diseases-suppressive systems are provided.

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754. Symbiotic dinitrogen fixation in forage legumes amended with high rates of de-inking paper sludge.

Allahdadi, I.; Beauchamp, C. J.; and Chalifour, F.P.

Agronomy Journal 96(4): 956-965. (2004)

NAL Call #: 4 AM34P; ISSN: 0002-1962

Descriptors: *Lotus corniculatus*/ *Medicago sativa*/ *Trifolium pratense*/ *Melilotus officinalis*/ forage legumes/ soil amendments/ pulp and paper sludge/ application rate/ *Sinorhizobium meliloti*/ *Mesorhizobium loti*/ *Rhizobium leguminosarum* bv/ *trifolii*/ nitrogen fixation/ nitrogen content/ dry matter accumulation/ nitrogen/ nutrient uptake/ Quebec

Abstract: The paper de-inking process produces a waste by-product, de-inking paper sludge (DPS), which contains paper fibers, clay particles, and inks and has high C and Ca and low N and P concentrations. Use of high rates of DPS to increase the soil organic matter thus requires provision of high rates of N for adequate plant growth. Using dinitrogen (N₂)-fixing forage legumes is an alternative to the N fertilization under such circumstances. In a 2-yr field study (1995 and 1996), the effect of different rates of DPS (0, 50, or 100 Mg dry matter ha⁻¹), applied once in October 1994, were evaluated on symbiotic N₂ fixation of forage legumes established on two soil types in Eastern Quebec, Canada. Symbiotic N₂ fixation was measured in alfalfa (*Medicago sativa* L.), birdsfoot trefoil (*Lotus corniculatus* L.), red clover (*Trifolium pratense* L.), and sweetclover (*Melilotus officinalis* L.); brome grass (*Bromus inermis* L.) was used as the reference (non N₂-fixing) crop. Dinitrogen fixation was estimated by the ¹⁵N natural abundance method. The percentages of N derived from the atmosphere increased significantly with DPS in the year of establishment (1995). In the first production year (1996), the effects of DPS on N₂ fixation were mainly observed at the first cut. Our results

show that DPS used as an organic amendment generally led to similar or greater forage legume productivity and greater N₂ fixation compared with unamended controls in the first production year and is compatible with sustainable agricultural practices.

This citation is from AGRICOLA.

755. Trace metal leachability from papermill ashes and sludge used as soil amendments.

Xiao, Chengqing University of Florida, 1998.

Notes: Thesis (M.S.). Includes bibliographical references (leaves 82-86).

Descriptors: trace metals/ leachability/ papermill ash/ sludge/ soil amendments

This citation is from AGRICOLA.

756. Trace metals and biochemical oxygen demand of pulp and paper mill effluents.

Shrivastava, V. S. and Yeole, P. M.

Nature, Environment and Pollution Technology 1(2): 121-122. (2002); ISSN: 0972-6268

Descriptors: biochemical oxygen demand/ biological oxygen demand/ chemical oxygen demand/ chemical oxygen demand/ effluent/ industrial wastewater/ industrial effluents/ industrial waste waters/ industrial wastes/ paper industry wastes/ pulp and paper industry/ pulp and paper industry waste waters (general)/ pulp wastes/ trace metals/ trace metals / trace-metal/ waste water/ wastewater analysis/ wastewater analysis/ India/ India, gujarat/ India, gujarat, satpura/ India

Abstract: Ukai-Songarh pulp and paper mill was selected for the present investigation. The mill is located in Satpura valley in south Gujarat. For the study, the effluents, amended soils and neighbouring plant samples were analysed for Cu, Zn, Cd, Pb, Ni, As, Hg and Fe. The obtained concentrations were found to be much higher. Effluents affect quality of soils and adjoining plants. The pulp and paper mill effluent samples have also been investigated for their COD and BOD.

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757. Treatment of heavy metal contaminated soils to reduce metal uptake by cultivations.

Calace, N.; Petronio, B. M.; Pietroletti, M.; Deriu, D.; and Pompili, L.

Recent Research Developments in Agronomy and Horticulture 1: 29-46. (2004)

Descriptors: acid soils/ application rates/ barley/ bioavailability/ chemical speciation/ copper/ growth/ heavy metals/ lead/ paper mill sludge/ phytoremediation/ phytotoxicity/ polluted soils/ pollution control/ soil amendments/ soil ph/ soil pollution/ soil types/ soyabeans/ spatial distribution/ uptake/ waste disposal/ waste management/ waste utilization/ zinc/ green bean/ snap bean/ soybeans

Abstract: This study was conducted to determine the effects of paper mill sludge addition on metal (Cu, Pb and Zn) distribution in soil, plant growth and metal uptake by barley (*Hordeum distichum* [H. vulgare]) at different rates of sludge addition to an artificially polluted soil. Moreover, after establishing the best paper mill sludge adding rate, the

same parameters were studied in a naturally polluted soil using barley, bean (*Phaseolus vulgaris*) and soybean (*Glycine max*) as test plants. The paper mill sludge added to the heavy metal polluted soils induced some changes in the chemical metal forms present in the soil. These changes in some cases mainly concerned the shift from mobile forms to less extractable forms; in other cases the formation of available compounds in which metals were strongly bound prevailed. Consequently, both the metal uptake by plants, depending on the nature of the metal, and some physiological parameters of plants, were modified. The mechanisms studied were dependent on soil characteristics, in particular to soil pH, and were strongly influenced by the composition of the paper mill sludge. In acid soils, the addition of paper mill sludge shifted pH values towards moderately basic values and reduced metal uptake. In basic soils, the addition of paper mill sludge reduced the toxic effects on plants without decreasing or increasing metal uptake, depending on sludge composition. It is concluded that paper mill sludge addition to heavy metal polluted soils might possibly affect phytopurification mechanisms.

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758. Use of bark and combined paper sludge for the revegetation of bark-covered land.

Beauchamp, C. J.; Camire, C.; and Chalifour, F. P.

Journal of Environmental Engineering and Science 5(3): 253-261. (2006); ISSN: 1496-2551

Descriptors: bark/ choice of species/ establishment/ growing media/ nitrogen fertilizers/ paper mill sludge/ phosphorus fertilizers/ plant residues/ potassium fertilizers/ phosphate fertilizers/ potash fertilizers/ potting composts/ rooting media

Abstract: This study investigated the use of bark and combined paper sludge to develop a suitable plant growth substrate and to establish a vegetation cover on bark-covered land. Field experiments conducted in Quebec, Canada, were established to determine the best plant growth medium, plant mixtures, and fertilizer application programme. The best soil cover consisted of 2.5 cm of combined paper sludge on top of 2.5 cm of black bark. On this soil cover, the Savoureux mixture in combination with birdsfoot trefoil (*Lotus corniculatus*), Lab02 in mixture with MR77, and birdsfoot trefoil in mixture with bromegrass (*Bromus inermis*) gave good vegetation growth and yields. For birdsfoot trefoil over all soil covers, the phosphorus and potassium fertilizer applications were required at 140 kg P₂O₅/ha and 160 kg K₂O/ha, respectively. These results suggest that combined paper sludge and black bark can be used as topsoil to favour plant establishment on bark-covered land.

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759. Use of de-inked paper sludge in potting mixes for geranium and zinnia production.

Tripepi, Robert R. and Koehn, Charlyn A.

In: 95th Annual International Conference of the American Society for Horticultural Science. Charlotte, North Carolina.; Vol. 33 (3); pp. 464; 1998.

NAL Call #: SB1.H6; ISBN: 0018-5345

Descriptors: horticulture: agriculture/ compositae: angiosperms, dicots, plants, spermatophytes, vascular plants/ geraniaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ de-inked paper sludge/ potting mix composition/ meeting abstract/ meeting poster/ sanitation/ waste management
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760. Use of fresh and composted de-inking sludge in cabbage production.

Simard, Regis R.; Coulombe, J.; Lalonde, R.; Gagnon, B.; and Yelle, S.

In: Beneficial co-utilization of agricultural, municipal and industrial by-products. Beltsville, Maryland, USA.) Norwell, Massachusetts: Kluwer Academic Publishers; pp. 349-361; 1998.

Notes: Meeting Information: Proceedings of the Beltsville Symposium XXII.; ISBN: 0792351894

Descriptors: horticulture: agriculture/ soil science/ waste management: sanitation/ cruciferae: angiosperms, dicots, plants, spermatophytes, vascular plants/ crop yield/ de-inking sludge: composted material, fresh material, paper mill waste/ meeting paper/ typic humaquod
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761. Use of lux-based biosensors for rapid diagnosis of pollutants in arable soils.

Palmer, G.; McFadzean, R.; Killham, K.; Sinclair, A.; and Paton, G. I.

Chemosphere 36(12): 2683-2697. (1998)
NAL Call #: TD172 .C54; ISSN: 0045-6535

Descriptors: application to land/ arable soils/ biosensors/ cadmium / copper/ crops/ diagnosis/ paper mill sludge/ pentachlorophenol/ pollutants/ polluted soils/ soil pollution/ soil types/ toxicity/ Britain/ land application/ United Kingdom
Abstract: A field trial, in Central Scotland, UK, demonstrated that crop yields were reduced with increased application of paper mill sludge to land. A suite of ecotoxicity assays, including luminescence response of lux-marked bacteria, respirometry and enzyme activity was used to assess toxicity of the paper mill sludge to the soil microbial biomass. The results from the use of the lux based biosensors correlated well with more traditional microbial indicators of soil pollution (respiration and enzyme activity). Concentrations of metals and organic contaminants in samples were confirmed using GFAAS and GC-MS, respectively. The main pollutant components of paper mill sludge were Cd, Cu and PCP (pentachlorophenol). The range of environmental bioassays used, with chemical verification, offered a rapid and comprehensive battery test for assessment of the ecotoxicity associated with paper mill sludge application to land.

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762. Use of organic wastes in substrates for pot-in-pot shade tree production.

Chong, Calvin and Lumis, Glen P.

Canadian Journal of Plant Science 80(1): 233. (2000)
NAL Call #: 450 C16; ISSN: 0008-4220.

Notes: 1999 Meeting of the Canadian Society for Horticultural Science.

Descriptors: horticulture: agriculture/ waste management: sanitation/ Aceraceae: angiosperms, dicots, plants,

spermatophytes, vascular plants/ Betulaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ Oleaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ pot in pot shade tree production: horticultural method/ paper mill sludge: organic waste/ wood chips: organic waste

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763. Use of paper mill wastes on agricultural soils: Is this a way to reduce nitrate leaching?

Kirchmann, H. and Bergstrom, L.

Acta Agriculturae Scandinavica: Section B, Soil and Plant Science 53(2): 56-63. (2003)

NAL Call #: 11 Ac82 ; ISSN: 0906-4710

Descriptors: agricultural soils/ arable land/ arable soils/ aromatic hydrocarbons/ cadmium/ carbon nitrogen ratio/ cellulose/ chemical composition/ copper/ decomposition/ fibre content/ hemicelluloses/ immobilization/ leaching/ mineralization/ nitrate/ nitrogen/ nitrogen content/ nutrient content/ organic carbon/ paper mill sludge/ polluted water/ pollution control/ polycyclic hydrocarbons/ sludges/ soil amendments/ soil organic matter/ soil types/ waste wood/ water pollution/ water quality/ wood fibres/ wood residues/ fiber content/ inorganic nitrogen/ organic matter in soil/ polycyclic aromatic hydrocarbons/ water composition and quality

Abstract: The term paper-mill waste is used for different products: de-inked fibre sludge, primary fibre sludge, secondary sludge, residual wastes and mixtures. This study was conducted to determine if any of these materials could be safely used on agricultural soils to induce net N immobilization, and thereby decrease nitrate (NO₃) leaching. Chemical characterization showed that secondary sludge derived from biological waste water treatment was a nutrient-rich material low in fibre content, whereas primary and de-inked fibre sludge were high in fibre content and low in nutrient content. Cellulose-C and hemicellulose-C amounted to 46 and 36% of the organic C present, respectively, and C:N ratios were approximately 130 in primary and de-inked fibre sludge. Incubation studies at 8 degrees C over 2 months showed that the decomposability of primary and de-inked fibre sludge in soil was not significantly different. Both showed lower decomposability than secondary sludge. Concentrations of inorganic N in soil declined to very low levels after application of primary and de-inked fibre sludge and their capacity for net N immobilization was 4.8-7.2 kg N t⁻¹ C added at 5 degrees C. However, contents of Cu, Cd and polycyclic aromatic hydrocarbons in de-inked fibre sludge limit its use on arable land. Only primary fibre sludge was found to be suitable as a nitrogen catch fibre material for use on agricultural soils. Reproduced with permission from the CAB Abstracts database.

764. Use of raw and composted paper mill sludges, municipal waste composts, and other waste ingredients in container nursery substrates.

Chong, Calvin and Purvis, Peter.

In: 102nd Annual Meeting of the American Society for Horticultural Science. Las Vegas, NV, USA.; Vol. 40(4); pp. 1048; 2005.

NAL Call #: SB1.H6

Descriptors: waste management: sanitation/ horticulture: agriculture/ Cornaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ Oleaceae: angiosperms,

dicots, plants, spermatophytes, vascular plants/ Rosaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ Saxifragaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ paper mill sludge/ municipal waste compost
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765. Using paper de-inking sludge to maintain soil structural form: Field measurements.

Nemati, MR; Caron, J; and Gallichand, J
Soil Science Society of America Journal. Jan/Feb 2000; 64(1): 275-285. 64(1): 275-285. (Jan. 2000-Feb. 2000) NAL Call #: 56.9 So3; ISSN: 0361-5995 [SSSJD4]
Descriptors: soil types/ soil structure/ hydraulic conductivity/ soil water retention/ bulk density/ correlation/ application rate/ Quebec/ stability/ paper mill sludge
Abstract: A high level of organic matter in soils is crucial to maintain structural stability but organic matter sources differ in their effectiveness in stabilizing structural units. Objectives of this study were, first, to determine the optimal rate of sludge and fertilizer application to improve soil physical properties, and second, to investigate a possible correlation between hydraulic conductivity and structural stability measurements. A 4-yr field study (1994-1997) was conducted on three different soil types to evaluate the effect of different amounts of deinking secondary paper sludge on the soil physical properties. The soil physical properties we monitored were structural stability, water desorption characteristics, bulk density, and saturated hydraulic conductivity. Structural stability was increased by 17% in silty clay soil (SCS) and 15% in loamy soil (LS), but decreased by 35% in sandy loam soil (SLS). Results suggest that the effect of sludge application (SA) is short-lived and that an annual application of sludge is necessary to obtain a year-to-year effect on structural stability. Measured bulk density dropped significantly in the SCS (4-10%) and in the LS (1-6%). A significant increase in air capacity and available water values revealed that SA increases both transmission and storage pores in the SCS. Field-saturated hydraulic conductivity (Kfs) was increased in the SCS, but decreased in the SLS and the LS. A good correlation was observed between structural stability and hydraulic conductivity measurements in the SCS and the LS.

This citation is from AGRICOLA.

766. Utilization of paper sludges for developing bed soils and seedling pots: Physico-chemical analysis of paper sludges.

Kim, G. Y.; Kim, C. H.; Sin, T. G.; Jung, H. G.; Lee, Y. M.; Song, D. B.; and Huh, M. R.
Palpu Chongi Gisul/Journal of Korea Technical Association of the Pulp and Paper Industry 39(4): 61-67. (2007); ISSN: 02533200 [PCGID].
Notes: Language of Original Document: Korean.
Descriptors: bed soils/ heavy metals/ paper sludge/ physico-chemical analysis/ plant nutrition/ seedling-pot/ crops/ grain (agricultural product)/ heavy metals/ newsprint/ nitrogen/ nutrients/ pigments/ raw materials/ silicon/ soils/ water absorption/ bed soils/ paper sludges/ seedling pots/ sewage sludge/ grain/ newsprint/ paper/ sludge/ soil
Abstract: Paper sludges collected from three different paper mills were physico-chemically analyzed in order to use them as raw materials for making bed soils and seedling pots. The sludge from a fine paper mill contained

lots of inorganic pigment particles used for coating, as those from a newsprint mill and a tissue mill had not. It was clearly through XRD analysis confirmed that all sludges included calcium carbonate. The paper sludge from the tissue mill contained the greatest amount of particles, which would contribute to water absorption and nutrient storage. The sludge from the fine paper mill had the highest density due to many inorganic elements. While the ash content and the total nitrogen content were the highest in the sludge from the fine paper mill, the C/N ratio was the lowest in the fine paper mill sludge. All sludges seemed to have insufficient contents of potassium. The sludges from the newsprint mill and the tissue mill showed more silicon contents than that from the fine paper mill. It was concluded that the sludge from the fine paper mill would be able to be the most efficient raw materials for making bed soils and seedling pots and the other two sludges would be more efficient for intensive culture for crops such as rice and grain with additional supplement of nitrogen and other nutrients.

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767. Value and potential contamination risk of paper mill sludge land application: A review.

Du, W.; Zheng, G. D.; Chen, T.-B.; Fu, B.-T.; Lei, M.; Gao, D.; Yue, B.; Liu, B.; and Zhang, J.
Shengtai Xuebao/ Acta Ecologica Sinica 28(10): 5095-5103. (2008); ISSN: 10000933 .
Notes: Language of Original Document: Chinese.
Descriptors: composting/ land application/ paper sludge/ resource/ risk assessment
Abstract: The pulp and paper industry generates a considerable amount of sludges from the paper making processes. With the development of paper making industry, the environment concerns about paper sludge have increased. Paper sludge has high water content from 75% to 80% and high organic matter. It is easily to be rotten and has odor, and also isn't inconvenient to transport and land application. Therefore, paper sludge should be stabilized and used non-hazardous treatment. Composting can be an effective strategy to stabilize the sludge and reduce its environmental risk prior to land application. The composting process biologically stabilizes heterogeneous raw paper sludge and reduces mass and volume and thus hauling costs. Paper sludge is rich in organic matter and other nutrients and its land application don't lead to the heavy metal contamination, the organic chemicals and nitrate leaching risk. Many studies involving paper sludge and compost land application highlight the effects on soil chemical and physical properties. Application of paper sludge can increase soil C, water holding properties and aggregation, also can improve soil structure, decrease soil bulk density, and promote the soil enzyme activity. Paper sludge and compost can also improve soil nutrients status, and increase crop production and has residual effect. It is a main avenue to dispose paper sludge that paper sludge after composting process mixes with chemical fertilizer as compound organic fertilizer.

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768. Value of paper mill sludge in agriculture: Crop yield, soil properties, and environmental impacts.

Gagnon, B. and Ziadi, N.
Recent Research Developments in Crop Science 1(1): 1-10. (2004)

Descriptors: agriculture/ carbon nitrogen ratio/ crop yield/ degraded land/ environmental impact/ immobilization/ industrial wastes/ paper mill sludge/ sludges/ soil degradation/ soil properties/ waste water/ waste water treatment/ environmental effects/ soil quality

Abstract: Intensive agriculture practices often result in soil degradation that can limit crop yield. Canadian pulp and paper industries dispose of large amounts of solid residues rich in C that can potentially maintain and restore the productivity of these degraded soils. Most residues produced locally by the pulp and paper industries are a combination of primary/de-inking and secondary sludge (CS). Our research has shown that CS may be applied to crops without any mineral supplement under cool and humid climates. When applied at appropriate rates, CS increases yield without producing any detrimental effects on soil quality. Compared with mineral N fertilizer crop response, the contribution of total N from CS reaches on average 40% in the year of application. Conversely, the sludge from primary waste water treatments or de-inking process (RS) are considered more as a soil conditioner. Their very high C to N ratio causes soil N immobilization. However, RS may be composted with farm manure or supplemented with mineral N to improve their nutrient content before land application. Reproduced with permission from the CAB Abstracts database.

769. The value, use, and environmental impacts of pulp-mill sludge additions to forest and agricultural lands in Europe.

Cabral, F.; Vasconcelos, E.; Goss, M. J.; and Cordovil, C. M. D. S.

Environmental Reviews 6(1): 55-64. (1998); ISSN: 1181-8700

Descriptors: agricultural land/ application to land/ forests/ groundwater/ leaching/ paper mill sludge/ pollution/ properties/ pulp and paper industry/ sludges/ soil amendments/ wastes/ environmental pollution/ farmland/ land application/ paper industry

Abstract: The current state of knowledge on the recycling of pulp sludge in the forest and agricultural lands as an alternative to disposal is reviewed. Effects of land application of pulp sludge on chemical and physical properties of soils, on leaching of chemical constituents to groundwater, and on yields of crops are discussed. Regions in Europe where land application of pulp sludge are potentially most beneficial are identified. Information on pulp production, pulping and bleaching methods, and treatments of the effluents, as well as its environmental implications, are also briefly reviewed. Reproduced with permission from the CAB Abstracts database.

770. Vermicomposting of paper mill sludge using an African earthworm species *Eudrilus eugeniae* (kinberg) with a note on its physico-chemical features.

Umamaheswari, S. and Vijayalakshmi, G. S.

Pollution Research 22(3): 339-341. (2003); ISSN: 02578050 [PORS]D

Descriptors: eudrilus eugeniae/ paper mill sludge/ vermicompost/ composting/ decomposition/ earthworm/ organic matter/ physicochemical property/ pulp and paper industry/ sludge/ eudrilus eugeniae/ pheretima sieboldi

Abstract: Paper mill sludge collected from the local paper factory premises was vermicomposted using an African species of earthworm *Eudrilus eugeniae* and physico-chemical features of paper mill sludge before and after composting was analysed which showed that macro and micro nutrients as well as physico-chemical features such as pH, pore space increased after vermicomposting. Electrical conductivity, bulk density was found to be reduced which indicates the better degradation of organic waste.

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771. Vermicomposting of sludges from paper mill and dairy industries with *Eisenia andrei*: A pilot-scale study.

Elvira, C.; Sampedro, L.; Benitez, E.; and Nogales, R.

Bioresource Technology 63(3): 205-211. (1998)

NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: cattle manure/ composts/ cows/ dairy wastes/ manures/ paper mill sludge/ physical properties/ pulp and paper industry/ sludges/ vermicomposting / paper industry

Abstract: Vermicomposting of paper mill sludges mixed with cattle manure using *E. andrei* was studied in a 6-month pilot-scale experiment. Initially, a small-scale laboratory experiment was carried out to determine the growth and reproduction rates of earthworms in the different substrates tested. In the pilot-scale experiment, the number of earthworms increased between 22- and 36-fold and total biomass increased between 2.2- and 3.9-fold. The vermicomposts were rich in nitrogen and phosphorus and had good structure, low levels of heavy metals, low conductivity, high humic acid contents and good stability and maturity.

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772. Waste management from pulp and paper production in the European Union.

Monte, M. C.; Fuente, E.; Blanco, A.; and Negro, C.

Waste Management 29(1): 293-308. (2009); ISSN: 0956053X [WAMAE].

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Descriptors: air pollution/ building materials/ construction equipment/ deinking/ energy conversion/ environmental impact/ incineration/ industrial waste treatment/ paper and pulp industry/ paper coating/ production/ pulp/ waste management/ waste treatment/ deinked pulps/ economic factors/ energy recoveries/ European pulps/ European unions/ high moistures/ in compositions/ inorganics/ process conditions/ pulp and paper productions/ pulp and papers/ recycled papers/ waste compositions/ waste recoveries/ waste incineration/ ash/ environmental impact assessment/ european union/ incineration/ moisture content/ optimization/ pulp and paper industry/ recycling/ sludge/ waste management/ air pollution/ coatings/ gasification/ moisture content/ paper industry/ paper products/ production/ pulps/ pyrolysis/ waste management/ waste papers

Abstract: Eleven million tonnes of waste are produced yearly by the European pulp and paper industry, of which 70% originates from the production of deinked recycled paper. Wastes are very diverse in composition and consist of rejects, different types of sludges and ashes in mills having on-site incineration treatment. The production of pulp and paper from virgin pulp generates less waste but

the waste has similar properties to waste from the production of deinked pulp, although with less inorganics. Due to legislation and increased taxes, landfills are quickly being eliminated as a final destination for wastes in Europe, and incineration with energy recovery is becoming the main waste recovery method. Other options such as pyrolysis, gasification, land spreading, composting and reuse as building material are being applied, although research is still needed for optimization of the processes. Due to the large volumes of waste generated, the high moisture content of the waste and the changing waste composition as a result of process conditions, recovery methods are usually expensive and their environmental impact is still uncertain. For this reason, it is necessary to continue research on different applications of wastes, while taking into account the environmental and economic factors of these waste treatments. © 2008 Elsevier Ltd. All rights reserved.

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773. Wheat and field beans grown on Gault Clay or a soil-forming material amended with paper mill sludge.

Sellers, G.; Christin, F.; and Cook, H. F. *Land Contamination and Reclamation* 13(1): 61-79. (2005); ISSN: 0967-0513

Descriptors: crop yield/ growth/ landfills/ organic amendments/ paper mill sludge/ waste utilization/ wheat/ Britain/ green bean/ snap bean/ United Kingdom
Abstract: Re-establishment of vegetation on landfill sites, as required by UK planning consents, frequently means establishing viable arable agriculture rather than grassland. However, there is currently little information on crop suitability or yield, especially where the land has been restored with clay subsoils. Results are presented from two years growing field beans and wheat on a landfill site just outside Brighton, England, which has been restored with Gault Clay. The site was restored in two ways. One area had a 1 m depth of Gault Clay applied to the top of the engineered landfill cap. The other area had 300 mm of Gault Clay overlain by 700 mm of potentially topsoil-forming material, formed mainly of screened building waste materials which looked suitable for use as a soil-forming material. The amendments tested were mineral fertilizer and paper-mill sludge. The results show that nothing grew well on the Gault Clay, even when amended. Furthermore, growth was better on the soil-forming material, but yields were still unsatisfactory even when amended with mineral fertilizer. The paper-mill sludge produced little improvement in growth and actually suppressed growth significantly on the Gault Clay, and the combination must therefore be questioned as a solution to restoration of capped landfill, brownfield or contaminated land situations. Reproduced with permission from the CAB Abstracts database.

774. Windrow composting of paper mill by-products: Scale-up and seasonal effects.

Das, K. C.; Tollner, E. W.; and Tornabene, T. G. *Compost Science and Utilization* 10(4): 347-355. (2002) NAL Call #: TD796.5.C58 ; ISSN: 1065-657X
Descriptors: ammonium nitrate/ carbon nitrogen ratio/ composting/ composts/ landfills/ maturity/ moisture content/ paper mill sludge/ poultry manure/ seasonal variation/ soil amendments/ stability/ temperature/ waste management/ waste utilization/ windrows/ poultry litter/ seasonal changes/ seasonal fluctuations/ swath

Abstract: A significant portion of byproducts generated at pulp and paper mills are biodegradable organics. Presently, over 70% of these byproducts are disposed in landfills. Composting can be an effective process to stabilize and reuse them in value-added applications. Laboratory research has shown that adding nitrogen amendments to a mixture of paper mill byproducts to achieve a C:N ratio of approximately 130 is sufficient to compost these organics. This paper describes evaluating the laboratory-developed mixes and amendments in a full-scale pilot. Two trials, one in fall and one in winter, were conducted to quantify seasonal variations. Each trial consisted of four windrows of approximately 85 tonnes each; two were amended with chicken litter and two with ammonium nitrate. Temperature, moisture, C:N ratio, volatile solids, pH, soluble salt contents, stability and maturity were monitored over the 76-120 days of composting. Data collected were analysed using a general linear model repeated measures design. Results indicate that seasonal variations in process were significant at the 10% level for temperature, moisture content, volatile solids content, soluble salts and stability. Although differences in process performance existed between autumn and winter, the results of this study clearly showed that mill solids composted in this process reached a satisfactory level of stability within 76 days in winter and 120 days in the autumn trial. Final product stability and maturity ranged between stability indices of 0.05 to 0.26 mg_{O₂}/g Solids/h and germination indices of 78.4 to 100%, respectively. Although the compost product from the winter trial was more stable (mg_{O₂}/g Solids/h basis), the germination indices were lower indicating phytotoxicity resulting from a less desirable composting process. Addition of low levels (5 to 6 g ammonium nitrate/kg Composting blend, dry basis) of nitrogen amendment was sufficient to develop an active composting environment, thus, confirming that laboratory-developed mixes perform similarly at full-scale. A key limitation in scale-up was the oxygen availability within windrows, which affected the duration of composting required to achieve stability. Stability levels of 0.10 mg_{O₂}/g Solids/h were achieved only after a minimum of 11 weeks (76 days in winter trial) in full-scale, compared to four weeks during laboratory trials.

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